TOPICS OF THE MONTH

Making things move

TWO or three articles in this issue focus attention on materials handling problems, which account for a very big slice of industry's wage bill but still receive comparatively little attention in the majority of industries. There is no doubt that, in most industrial undertakings, a careful study of such problems, followed by the introduction of a system designed to cut the movement of materials and products down to a minimum, can work wonders with the cost sheet.

Because our special feature this month is mainly concerned with the movement of bulk or packaged materials, it should not be overlooked that in the chemical and allied industries the efficient movement of liquids and gases through a process or works also presents big problems. It should be recognised that this is all part of the one big subject of materials handling, and this broad view should be adhered to in planning a particular project. The only way in which maximum efficiency, and minimum costs, can be achieved is by making an overall survey of the operations involved in moving materials, liquids and gases and then seeing how best they can be fitted in together.

With the more complicated manufacturing operations, and with planning carried out by a team of technologists each a specialist in a particular field, albeit with central supervision, this ideal is not easy to achieve. But there has been increasing interest lately, along with work study and methods study techniques, in the use of scale models as an aid to planning. These are surely a valuable asset. Indeed, it is surprising that scale models have only recently received such wide interest, seeing that when a project engineer creates a model—a miniature version of the plant he is going to build—he is only exercising the same principle of caution as the chemical engineer does when he sets up a pilot plant before venturing into large-scale designs.

It is interesting to note that the value of scale models in deciding layout is confirmed by a team of experts which recently carried out a survey of materials handling problems in the Bristol area of England. A number of factories and installations were visited, embracing a variety of industries, and the problems they found seem to be fairly typical of materials handling everywhere. One useful observation, for instance, is that in many processes where soluble dry materials form constituents of a final wet or plastic mixture, it is often possible to make up an aqueous solution of these dry materials and pump them to the batch mixer, thus saving the transportation of sacks or bags through the factory, often through many floors. Examples are trisodium phosphate, sodium silicate in soap manufacture and salt in the form of brine for pickling. Transportation by pumping is not confined to soluble materials. Many substances such as paper pulp, coal fines, gravel, china clay, farinaceous compounds, etc., can be brought to a slurry with water and pumped to a distant process or storage point where, if necessary, the water is extracted by rotary filter, suction screen or press and returned for re-use as a carrier.

While a very great variety of plant and equipment is available for materials handling problems of all kinds, improvisation has a useful place, too. Thus a tea firm made a very good powered roller conveyor from a length of gravity rollers by the judicious use of two narrow lengths of canvas belting placed round the length of the rollers and stretched tightly. Power was applied from a ½-h.p. motor at one end and thus the canvas belts were made to move over the rollers. The conveyor is powerful enough, apparently, to carry a load of 1 cwt. up a gradient of one in four.

The report of the Bristol team of experts, published in booklet form by the Bristol & Bath Productivity Association (price 3s.) is well worth studying by anyone with materials handling problems. There are some useful recommendations on such subjects as palletisation, the loading of lorries, conveyors, lifting appliances, pumping and suction, while the value of manual handling, where appropriate, is not overlooked.

Big new chlorine plant for Britain

INSTALLED capacity for chlorine manufacture in the United Kingdom has been increased by some 5% with a new plant recently started up by the Associated Ethyl Co. Ltd. at Ellesmere Port, Cheshire. New facilities there also include a chlorine-recovery plant, to be brought into operation later this year, which is believed to be the first of its kind in Europe.

The chlorine plant is adjacent to the company's works for the production of tetraethyl lead anti-knock compounds (the subject of an extensive, illustrated article in CHEMICAL & PROCESS ENGINEERING, 1954, **35** (4), 115-120). The production of anti-knock compounds calls for large quantities of chlorine and, although the Ellesmere Port factory includes a plant for producing metallic sodium and the electrolysis of fused sodium chloride in Downs cells also provides a theoretically equivalent quantity of chlorine for the manufacture of ethyl chloride, additional chlorine is required to make up for process losses, to make ethylene dichloride and also to extract bromine from sea-water at Hayle, Cornwall, and Amlwch, Anglesey. The original intention was that this large amount of chlorine would be purchased from outside sources, but it later became apparent that the required quantity might not be available after the end of 1957 and, accordingly, the company decided to install its own plant.

The capacity of the plant was chosen so that it would be adequate for the increasing demand for chlorine for a period after the commissioning. The

decision to produce the chlorine by a conventional process of brine electrolysis has resulted in the availability of considerable quantities of by-product caustic soda and hydrogen.

For the process, mercury cells as designed and operated by Badische Analin & Soda-Fabrik A.G., Germany, were chosen. The B.A.S.F. process of brine purification, dechlorination and resaturation was also adopted. Equipment for liquefaction of chlorine follows a similar general pattern to the existing plant for liquefaction of Downs cell chlorine, in that chlorine drying is by vitriol circulation through towers, compression by Nash compressors, and liquefaction is accomplished by two-stage refrigeration from a CO_2 system.

An interesting feature of the plant, designed for producing liquid chlorine, is that, unlike most chlorine-producing units, it does not provide any flexibility in the distribution of chlorine gas for the manufacture of chlorine derivatives. The chlorine-recovery process, developed by Diamond Alkali Co., U.S.A., provides for utilisation of dilute chlorine gas which has passed unliquefied through the liquefaction system, and also vent gases resulting from air-pressure transfers of liquid chlorine.

This plant, of which further details will be given in a forthcoming issue, adds to the increasing self-reliance of Associated Ethyl, whose principal purchased raw materials are now reduced to lead, ethane, ethylene and salt, of which, however, the company remains a major consumer.

Effluent analysis methods

A CONSIDERABLE stimulus has been given to the solution of effluent problems in Britain in recent years, but one drawback has been the lack of any accepted methods for the analysis of trade effluents. A collection of some 40 recommended methods of analysis, which have been tried out under a variety of conditions, is being made available as a result of work carried out by a joint committee set up by the Association of British Chemical Manufacturers and the Society for Analytical Chemistry. Speaking at lunch given by the A.B.C.M. to the members of the committee, Mr. N. F. Patterson, O.B.E., chairman of the A.B.C.M. Trade Effluents Committee, pointed out that only after accurate measurements over a period of time can the effect of constituents of trade effluents on the receiving waters be known. For this reason the A.B.C.M. is recommending to its own members that they should regularly analyse trade effluents discharged to rivers or to local authority sewers.

Dr. A. Key, Senior Chemical Inspector, Ministry of Housing and Local Government, and chairman of the Ministry Committee on Methods of Analysis for Sewage and Sewage Effluents, who was also present, supported Mr. Patterson's recommendation of trade effluent analysis and welcomed the publication of the book 'Recommended Methods for the Analysis of Trade Effluents.'* If small rivers are going to be maintained fit for all their proper uses, he said, and at the same time increasing quantities of increasingly complex liquid wastes were to be disposed of, then it is essential to know what those liquid wastes really are; a mere qualitative description no longer suffices.

* W. Heffer & Sons, Cambridge, 42s.

Ion-exchange resins in molasses processing

THE unsteadiness of ion-exchange resins and the inadequate knowledge of their properties restricted, until lately, the range of their industrial applications. However, new developments give promise of much wider applications in the future, as can be seen from the introduction of ion-exchange techniques into sugar manufacture, where previous attempts to demineralise sugar by these techniques had to be abandoned because the ion exchangers in use at that time could not stand up to prolonged use in the presence of sugar juice and lost their capacity. However, with the advent of synthetic exchangers, the situation was changed.

The possibility of further applications for ion-exchange resins is discussed by D. Bourguignat in *Chimie & Industrie*, 1958, **79** (4), 439-443, where he describes experiments on the treatment of molasses—a material that is particularly 'rough' on ion exchangers. An installation capable of treating 1 metric ton per day of molasses was operated for 24 hr. a day for over six months. The ion-exchange properties of the exchangers did not deteriorate and the stability of the resins was concluded to be completely satisfactory. Sugar was obtained regularly, at the outlet, in the form of a coloured juice with a concentration of 5 to 7% and a purity of 92 to 95%. A trial boiling carried out with this juice made it possible to obtain a commercially satisfactory crystallised product.

The recovery of betaine was not given any particular attention owing to the poor market for this product. It was thought, however, that a recovery of 60% of the quantity of betaine initially present could be effected very easily.

By elution with hydrochloric acid it was possible to recover in the solution 70 to 80% of the glutamic acid with a purity of 50 to 60%. The concentration of glutamic acid in this eluate, while it was not made the object of any close study, was of the order of $2\frac{1}{2}$ to 3%.

Observations made in the course of these and previous studies now make it possible to employ ion exchangers safely in very complicated organic media. It should be appreciated that, from the point of view of complexity, molasses is a particularly well-chosen example. In fact, after the dilution of the molasses, precipitations form which have the tendency to clog the exchangers. The techniques developed in the course of these experiments made it possible to overcome this inconvenience. By the use of carefully chosen methods it was possible to obtain, by simple filtration, the classification of a number of different substances.

M. Bourguignat concludes that it is possible to envisage the application of ion exchangers over a very wide field, including glycerine, glycol, syrups and various organic products.

New uses for gypsum and anhydrite

GYPSUM has emerged in recent years as one of the most important non-metallic minerals used in modern industry. World production—at present roughly 30 million tons—has more than doubled since the war and is expanding at a remarkable rate, largely because of the increasing use of the material in building construction. In the chemical industry, gypsum is known chiefly as a raw material for the manufacture of sulphuric acid, for which a number of processes have been tried out in Europe. Other processes aim at the conversion of gypsum mixed with coal, coke, clay or other substances into calcium sulphide, sulphur, sulphur dioxide and lime, while various plants have utilised, in connection with the Haber process, the chemical principle of double decomposition to produce ammonium sulphate from gypsum, ammonia and carbon dioxide. In all these processes it is much more advantageous to use anhydrite as the raw material, for then the considerable amount of heat required for dehydration and the freight on water content are obviated.

Anhydrite, of course, finds one of its principal uses in the manufacture of ammonium sulphate, while sulphuric-acid manufacture is an equally important use. In Britain, the original decision to extend the anhydrite (and pyrites-burning) plants was undoubtedly justified when sulphur was critically scarce and expensive, and prospects of improved supplies seemed bleak. In the several years that have since elapsed it has again become cheaper to make acid from elementary sulphur. Nevertheless, the increased use of anhydrite can be justified not only because it reduces dependence on imported acid-making materials, but because it permits the production of cheaper acid than is possible when using pyrites, which at present accounts for the largest item in the country's sulphur import bill. The substantial increase in cement-making capacity, mainly in areas where it was much needed, is also to be noted.

These are among the points made in a report on gypsum and anhydrite following a survey by the Mineral Resources Division of Overseas Geological Surveys (H.M.S.O., 7s. 6d.). The abundance of these two materials which the report reveals, along with the extensive range of uses in the building and other industries, makes one wonder why their use in the chemical industry has been so limited; surely there are grounds for giving much more attention to the possibilities of manufacturing other chemical products from them than has been evident hitherto? At the Chemical Research Laboratory in Britain, cheap, low-grade gypsum has been successfully used for sulphide production, while waste gypsum from an industrial process, available in large quantities at a nominal cost, was also found to be suitable and has been used successfully in a small pilot plant. Elsewhere, a process has been described (*Z. angew. Chem.*, 1920, **33**, 49) for the production of elementary sulphur from anhydrite, and the sulphur so obtained is claimed to average a purity of 99.95%. There are doubtless other possibilities which could be explored. Incidentally, large quantities of artificially prepared gypsum in the form of a fine precipitate arise as a by-product of various operations in chemical industry, principally in the manufacture of phosphoric acid and triple superphosphate from phosphate rock or bone phosphate; by-product gypsum, however, represents only a small proportion of the gypsum used in industry.

More chemicals from petroleum in Europe

IN our March issue we presented a special survey of the petroleum chemicals industry and told how European producers, aided by new advances in technology, were laying plans for considerably expanded production. The latest figures confirm that European production of petrochemicals is expanding at a very rapid rate. Total capital invested (in terms of plants in operation at the given date) rose to 550 million dollars by the end of 1957. This is an increase of nearly 140 million dollars, or one-third since the end of 1956. Investment is expected to rise even more rapidly to nearly 1,200 million dollars by the end of 1960.

What this means in terms of production can be seen from the fact that the total carbon content of petroleum chemicals produced in O.E.E.C. countries rose from some 470,000 tons in 1956 to 630,000 tons in 1957, and the 1958 total production is expected to rise to 830,000 tons. As a result of investment planned up to the end of 1960, total production is expected to increase to over 2 million tons, or over three-quarters of a million tons more than last year's forecast of the growth due to investment up to the end of 1959. This expansion will cover, above all, synthetic rubbers of various types, polythene and ethylene oxide derivatives, solvents and raw materials for plastics and detergents.

With all this, it is hardly surprising that there is a corresponding activity in the plastics industry, and the O.E.E.C. Chemical Products Committee, which reports on this situation, also notes that, as in the past few years, the most rapid expansion has taken place in the thermoplastics group, where sales rose by 24% over 1956 to reach nearly 680,000 tons. Production of thermosetting plastics rose by 17% in 1957 to reach 570,000 tons. Total sales of plastics materials by O.E.E.C. countries reached the figure of 1.4 million tons—19% higher than in 1956, and between four and five times the figure for 1950.

Expansion will undoubtedly continue, especially for thermoplastics, although its rate is difficult to forecast.

Seeing the unseeable

A MAGNETIC device which makes it possible to pinpoint the position of a piece of metal hidden inside an opaque or solid covering has been developed in connection with explosive charges used for perforating oil-well cases. This device may well have applications in other fields where it is necessary to determine the location of an ' unseeable ' metallic part and where techniques such as *x*-ray photography or fluoroscopy, ultrasonics and dielectric or capacitative measurement cannot be used.

When an oil well has been drilled and cased, speci-

ally constructed explosive charges are lowered into the casing to a required depth and, when detonated, the charge ' squirts out ' jets of metal at high speed. The jets puncture the casing and penetrate the rock, freeing the oil and allowing it to enter the well. One type of charge, which is cup-shaped, carries a curved, disc-shaped steel barrier cast within the explosive charge. This barrier is designed to focus the explosive shock forces so as to achieve a maximum effect.

This means that the steel barrier has to be precisely centred inside the charge, and hitherto there has been no satisfactory way of checking its exact disposition. The answer has been found in the development of a ' magnetic concentricity gauge ' which can detect small variations in magnetic objects. It measures how much the steel barrier is off-centre, tilted, or both.

This information is obtained by spinning the charge in a magnetic field. If the steel barrier is centred in the charge, the effect on the flux pattern is negligible. If the barrier is in the wrong position, small variations are created in the magnetic field as the charge rotates. These variations induce a voltage in a sensing coil and the resulting signal, when amplified, is used to obtain the necessary data.

According to a recent bulletin from the Stanford Research Institute, U.S.A., in which this development was described, a gauge has been constructed which provides for automatic lighting of a lamp when the shaped charge under test contains a barrier that is off-centre or tilted. It also provides for setting the probe sensitivity at different levels.

It started with cream separators

HOW an invention that was aimed primarily at saving dairy farmers much time and labour developed also into a useful piece of equipment for the processing of industrial liquids is revealed in the story of the continuous separator devised by the Swedish engineer Gustaf de Laval. It was the discovery that the cream in milk was composed of small globules of fat, lighter than milk, that led in time to the idea of using centrifugal force to separate the cream, instead of skimming it off by hand. In 1874 a primitive but passably workable milk centrifuge was exhibited in Bremen, and it was an article about this machine that focused de Laval's attention on the problem of separating cream. In an astonishingly brief time he succeeded in designing the first continuous separator.

Experiments at the Stockholm Gasworks resulted in the successful use of de Laval's separator for separating ammoniacal liquor from coal tar. This circumstance indirectly brought him into contact with Oscar Lamm, a businessman and mining engineer, leading to a collaboration which culminated in the formation of A.B. Separator, the parent company of the Alfa-Laval/De Laval Group.

The group has now celebrated its 75th anniversary with the issue of an illustrated souvenir brochure which contains the history of its various enterprises. Cream separators are still one of the group's most important products, but as early as 1896 De Laval separators were coming into use industrially for liquids other than milk, being used in yeast factories for separating the yeast cells from the wort. The yeast separator was the prototype for the huge nozzle separators, with throughputs of up to 22,000 imp. gal./hr. and 80-h.p. power consumption, which are used, as one example, in the starch industry, where they do away with the need for decanting tables.

Potassium chloride from sea bittern

A NEW process whereby potassium chloride of high purity can be obtained from the waste solution left over after the solar evaporation of sea-water for salt-making is reported from India. For a country whose indigenous production of potassium chloride is almost negligible at present and whose annual requirements by 1960-61 are estimated at 47,500 tons, such a process would seem to have considerable economic importance. India produces some 3½ million tons p.a. of salt by solar evaporation and it has been estimated that from the resulting waste bittern about 85,000 tons of potassium chloride can be recovered.

The bittern discharged from salt pans at 29 to 30° Bé contains magnesium and potassium salts and combined bromine. Further concentration to 34° Bé deposits common salt containing magnesium sulphate and the double salt, carnallite. It is, therefore, necessary to remove magnesium sulphate prior to the concentration of the bittern for obtaining carnallite. This can be achieved by double decomposition with calcium chloride. After the insoluble calcium sulphate is filtered, the bittern contains mainly potassium and magnesium chlorides from which carnallite can be crystallised by concentration. The latter on fractionation yields potassium chloride. Cheap calcium chloride from Solvay process waste can be used for this purpose. It can also be obtained by treating magnesium chloride, a by-product of this process, with lime.

From the experiments carried out at the Central Salt Research Institute, Bhavnagar, and reported by G. T. Gadre, A. V. Rao and H. M. Bhavnagary in the *Journal of Scientific and Industrial Research*, **17A** (3), 141-144, it appeared that the optimum conditions for the separation of potassium chloride entailed, first, the precipitation of calcium sulphate from the bittern at room temperature by the addition of calcium chloride, 10% in excess of the theoretical amount, the precipitate then being agitated for 1 hr., filtered off and washed with water to remove the adhering potassium chloride. The desulphated bittern is concentrated to a point where the temperature of the boiling solution is 123°C. It is cooled to room temperature when the crude double salt crystallises out. This is dissolved in water and the solution concentrated to the super-saturation point. The liquor is then cooled to 20°C. and potassium chloride separates, to be filtered, washed with a solution of potassium chloride and dried at 110°C.

In a large-scale experiment based on these conditions and using a 10-litre batch of bittern, 345 g. of potassium chloride was recovered, the purity of the product being 96.8%.

Steam traps can be an invaluable aid to efficiency in process plants but their manner of operation and correct use are not generally well understood. This article surveys the various types of traps and the uses to which they can be put, concluding with some comments on trap selection, care and maintenance.

STEAM TRAPS

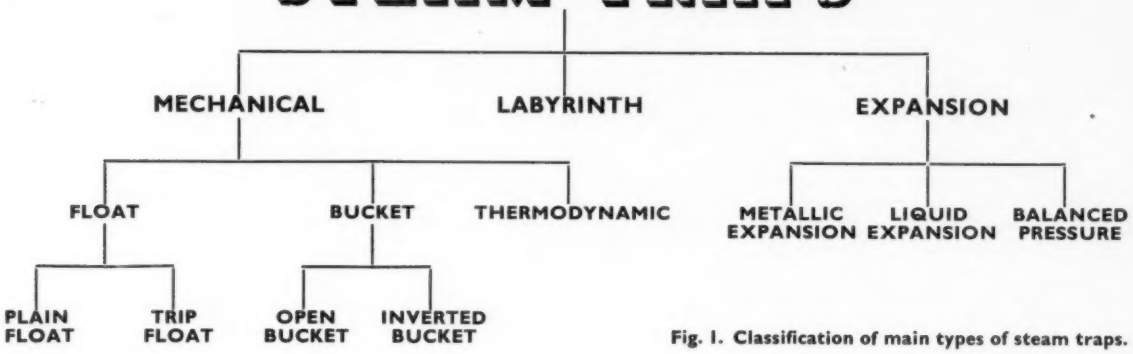

Fig. 1. Classification of main types of steam traps.

By E. W. Jackson, A.M.C.T., A.M.I.Chem.E.

WHERE steam is used as a heat-transfer medium for process work its latent heat is given up and the water formed by condensation must be removed from the equipment or, as a result of the accumulation of condensate, the surface area available for heat transfer will be reduced. However well lagged the steam distribution mains they always lose some heat, and the condensed water must be removed from the steam distribution system.

Air, which is present in the steam spaces of plant before start up, and which is usually present in small quantities in steam, must also be removed from the equipment, otherwise the rate of heat transfer will suffer. There are two reasons for this, the first being that the air tends to accumulate at the heat-transfer surface and, because of its low thermal conductivity, it causes a significant fall in the overall heat-transfer coefficient. The second reason is that, as the quantity of air in the system increases, the partial pressure of the steam is reduced, and the result is a lower temperature difference between the steam side of the equipment and the material being heated. Some types of steam trap will discharge air from the system, other types will not, in which case provision must be made for air removal.

Steam traps may be classified into three groups: mechanical traps, labyrinth traps and expansion traps. The two main groups are mechanical and expansion traps, and there are several types of trap in each group as shown in Fig. 1.

Float traps

A section of a plain float trap is shown in Fig. 2. Condensate enters the trap through the top connection and causes the float to rise; this in turn opens a valve which allows the condensate to be discharged through the side connection. In Fig. 2 the valve is a slide valve, but in some designs (Fig. 12) the valve is a ball valve. Plain float traps are designed so that the valve is covered by condensate before it can open, thus preventing the discharge of steam. This trap discharges condensate continuously, and the amount the valve is open at constant steam pressure depends on the rate of condensate formation, as this controls the level of the float. Plain float traps are very flexible; they will operate on fluctuating steam pressures and steam loads, and the condensate is discharged as soon as it is formed. However, there is a limit to the pressure that can be used with a particular trap because the steam pressure acts on the valve, and above a certain pressure the float will not have sufficient buoyancy to open the valve. This trap is not suitable for use where it is subject to movement, such as on board ship.

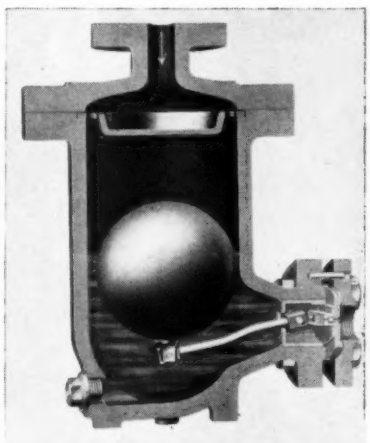

Fig. 2. Section of plain float trap.

The trip float trap is similar to the plain float trap, the difference being that the float rises with the condensate and, when the trap is full, the float operates a trip mechanism which opens a valve and discharges the condensate. The float descends, resets the trip mechanism and closes the valve. This type of trap is suitable for situations where the rate of condensate formation is very low, but at times may be high. The trap will also operate when subject to movement. Maintenance costs on trip float traps are high because these traps have a large number of working

parts which are subject to wear.

Float traps can be used in contact with superheated steam. They will not withstand water hammer, and they do not discharge air from the system unless provision has been made for this. This point is discussed later.

Bucket traps

The open-top bucket trap (Fig. 3) utilises the buoyancy of a floating bucket to close the valve which allows condensate to be discharged from the trap. The trap should be filled with water before use to float the bucket and seal the valve. Condensate enters the trap through the connection in the body and collects round the bucket. When the condensate level reaches the top of the bucket, condensate overflows into the bucket, causing it to sink and open the discharge valve. The steam pressure then blows out the condensate *via* the top connection until the bucket again floats and closes the valve. The open-top bucket trap will not discharge air.

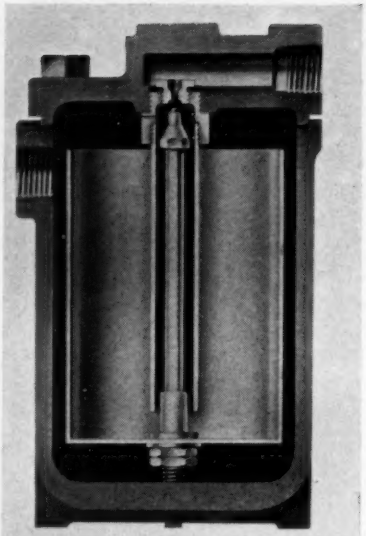

Fig. 3. 'Ogden' open-top bucket trap.

Like the open-top bucket trap, the inverted bucket trap (Fig. 4) should be filled with water to close the outlet valve before putting it into service. The bucket has a small hole in the top which allows steam to leak into the top of the trap where it condenses. The method by which the trap operates may be seen in Fig. 4. In position (1) the discharge valve is open and condensate is being discharged. Position (2) shows the trap when steam has entered floating the bucket and closing the discharge valve; a small leak of steam and air, if present, takes place through the small hole in the top of the bucket. In (3), steam has condensed and more condensate has entered the bucket, and in (4) the buoyancy of the bucket is insufficient to keep it floating and the discharge valve has opened. This trap can be used where there is movement such as on a ship, and it will allow air to escape slowly from the system. Inverted bucket traps are not very flexible; they do not operate too well where there are fluctuations in pressure and load, and the trap always wastes a little steam.

Bucket traps will withstand severe conditions such as water hammer; their mechanism is simple and very little can go wrong. Like the plain float trap there is a limiting steam pressure above which a particular trap cannot operate. They can be used with superheated steam, but under certain conditions they can lose their water seal, *e.g.* if there is a sudden drop in steam pressure the water may flash to steam; this can be prevented by fitting a non-return valve just before the trap inlet.

Thermodynamic trap

The thermodynamic trap utilises for its operation the conversion of the

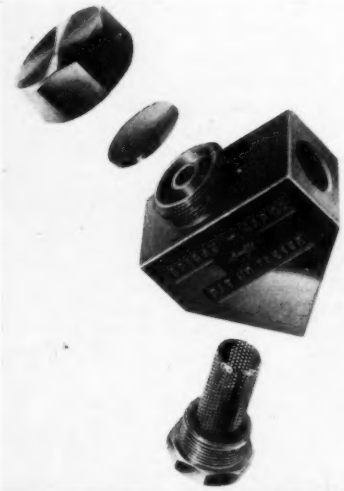

Fig. 5. Exploded view of ¼-in. thermodynamic trap.

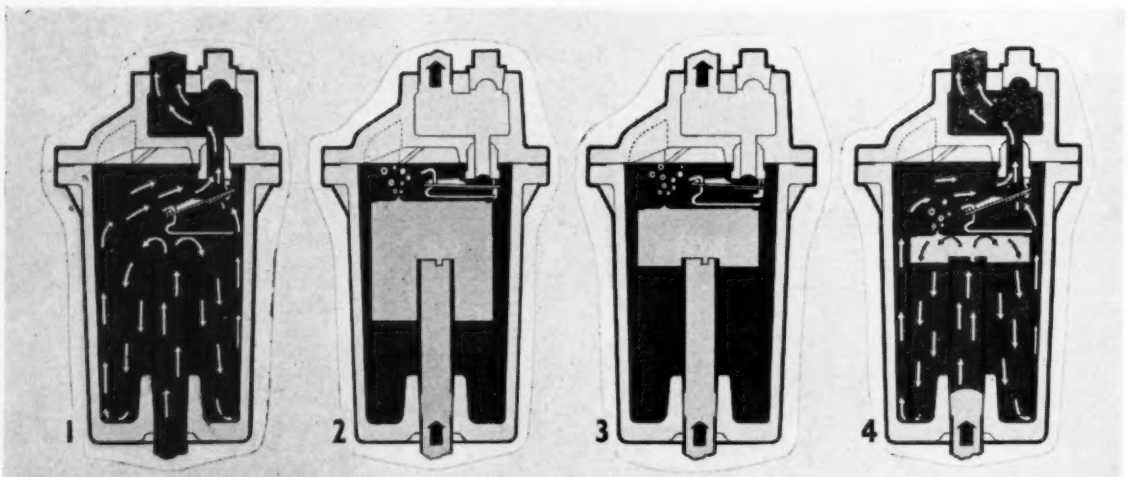

Fig. 4. Sequence of operation of inverted bucket trap, as explained in the text above.

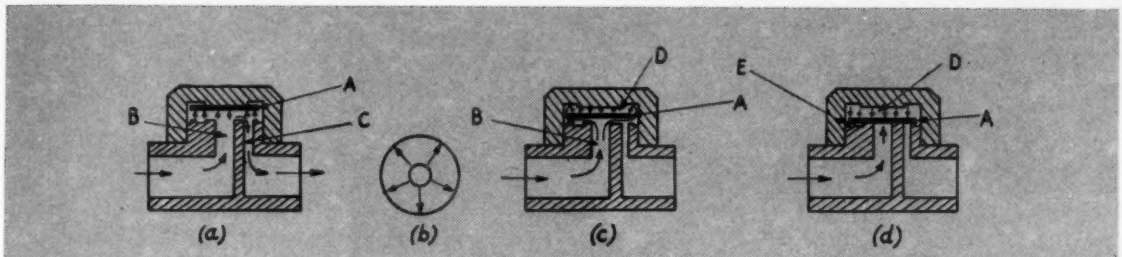

Fig. 6. Operation of thermodynamic steam trap (for explanation, see text below).

kinetic energy of the fluid (steam) into potential energy, and the conversion of potential energy into kinetic energy. A new development in this field has recently been introduced[1] and is illustrated in Fig. 5. The operation of the trap is illustrated in Fig. 6. The inlet passage feeds into an inlet orifice *B* which terminates centrally below a disc *A*. The outlet orifice *C* is smaller in section than the inlet orifice.

Fig. 6 (*a*) shows the trap when air and condensate are entering it at a comparatively low pressure. The disc is lifted from its seat, and the condensate and air pass underneath the disc and leave the trap *via* the outlet orifice. The flow of air and steam takes place because there is a pressure difference across the trap. At the inlet orifice *B*, as the potential energy falls the kinetic energy increases; the jet of fluid impinges on the underside of the disc and flows radially across it (Fig. 6 (*b*)). The area through which it flows increases and therefore there is a fall in velocity; this means that the kinetic energy is reduced, and the potential energy is increased, so there is a gradual drop in pressure across the disc from the circumference to the centre, *i.e.* the pressure at the edge of the disc is higher than at the centre, and the pressure above the disc is equal to or higher than the pressure at the circumference. Thus there is a pressure difference between the top and bottom of the disc.

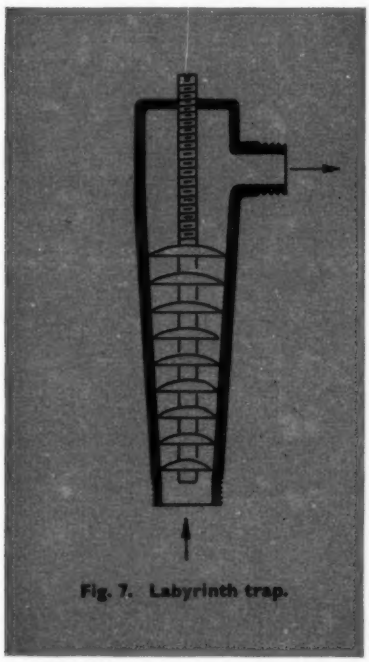

Fig. 7. Labyrinth trap.

When air and cold condensate are passing through the trap, the velocity is too low for the pressure difference to have any effect, but as a result of the pressure drop across the inlet orifice *B*, hot condensate will flash to steam as it passes through *B*, and the increase in volume which takes place with the change of state from water to steam means that the jet velocity increases to such an extent that the pressure difference across the disc is sufficient to cause it to move towards the inlet orifice (Fig. 6 (*c*)). At the same time the steam is deflected above the disc, and as it is brought to rest in the chamber *D* its kinetic energy is changed to potential energy, and the steam pressure retains the disc on its seat (Fig. 6 (*d*)). To enable the condensate temperature to approach the steam temperature before the trap closes, the disc is provided with concentric grooves on the underside to dissipate some of the energy in the jet in the form of eddies, thus delaying the build-up of the pressure difference across the disc and the closing of the trap.

The mixture of steam and condensate cannot escape from the chamber *D* because of the outer seat ring *E*, and the opening of the trap depends upon condensation of the steam in the chamber above the disc. The time taken for condensation to take place depends upon a number of factors amongst which are external temperature and draughts. If there is no condensate when the disc rises from its seat, the high-velocity jet of steam will build up sufficient pressure differential to reseat the disc almost instantaneously.

The thermodynamic trap is very compact, it has a large discharge capacity, and it is very flexible. It will work within the pressure range 10 to 350 p.s.i. without adjustment; it will withstand water hammer as well as vibration, and it can be fitted in any position. The trap has some limitations. It is not recommended for use at pressures below 10 p.s.i. gauge unless the discharge piping system has been carefully sized and designed to give the minimum back pressure. The trap will remove air from the system because it is usually present in most quantity alone during start-up when the velocity is low. Where the velocity of air is high, it will seat the disc in a similar manner to steam and, as there is no steam to condense, the opening of the trap will depend upon the rate of air leakage from the chamber above the disc. If the trap is used in a system where a large quantity of air must be vented quickly, separate provision should be made to release the air. The thermodynamic trap

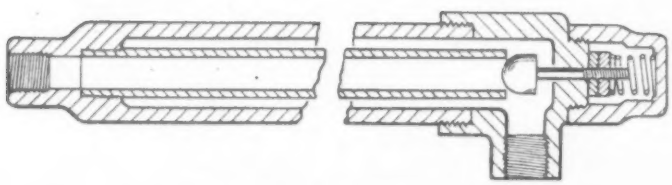

Fig. 8. Metallic expansion trap.

should not be fitted at the end of a long length of horizontal pipe, as under these circumstances it is possible to get a mixture of condensate and steam passing continuously which will not allow the trap to close.

Labyrinth traps

A section through a labyrinth trap is shown in Fig. 7. It consists of a series of chambers into which the condensate can pass *via* the clearance between the baffles and the trap body. Cold condensate will pass through the trap, but because of the gradual pressure drop across the trap hot condensate will flash to steam as it passes from chamber to chamber; this increase in volume slows down the condensate flow and prevents the escape of the process steam.

The clearance between the baffles and the trap body is adjustable, and the trap must be adjusted to suit the working conditions. It has no moving parts and very little can go wrong with it, but it is not suitable for use where the load is unsteady or where there is a variation in steam pressure. A drop in steam pressure will allow steam to escape, and an increase in steam pressure will cause condensate to be held back.

Expansion traps

All expansion traps depend for their operation on the fact that the temperature of steam (unless the steam is superheated or mixed with air) is constant for a particular pressure, whilst the condensate cools to a temperature below that of steam.

The body of a metallic expansion trap (Fig. 8) is usually made from iron and the central tube from copper. Cold condensate enters the central tube, passes through the valve and leaves the trap *via* the side connection. As the condensate temperature rises the copper, which has a higher coefficient of thermal expansion than iron, expands and eventually closes the valve. The disadvantage of the metallic expansion trap is that, because of the low coefficient of expansion of metals, the trap must be 3 to 4 ft. long to obtain sufficient movement to give a reasonable rate of condensate discharge through the valve. Various devices have been used to reduce the length of this type of trap, but these have not always been successful.

The liquid expansion trap (Fig. 9) is similar in operation to the metallic expansion trap. A central cylinder is fitted with a piston attached to a rod, which passes through the end of the cylinder, and the end of the rod is fitted with a ball valve. The rod is surrounded by a corrugated flexible tube. This tube is fixed to the piston at one end and to the cylinder at the other; the space between the tube and the cylinder is filled with a liquid so that the corrugated tube acts as a leakproof gland between the rod and the liquid. Cold condensate enters the trap *via* the valve and passes out of the trap through the side connection. As the condensate temperature rises it heats the liquid which expands and exerts a pressure on the piston which moves the rod, gradually closing the valve to such an extent that only a trickle of condensate can escape. As the trap cools the reverse process takes place, the opening of the valve being assisted by the steam pressure.

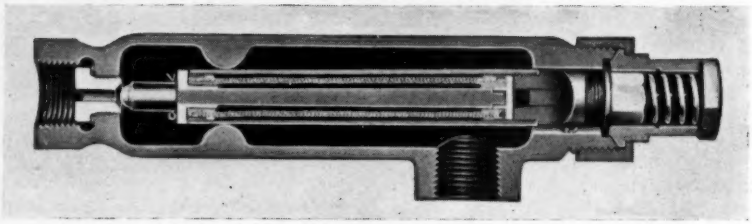

Fig. 9. Liquid expansion trap.

Metallic and liquid expansion traps must be adjusted to suit the conditions under which they are to be used. To do this, the adjustment nut is turned until steam blows from the trap; the nut is then turned in the opposite direction until the flow of steam ceases; the nut is then locked in position. Where the sensible heat in the condensate can be put to use, these traps can be adjusted to discharge condensate at low temperatures. Metallic expansion and liquid expansion traps will withstand water hammer, vibration and superheated steam. They do not respond well to fluctuations in pressure.

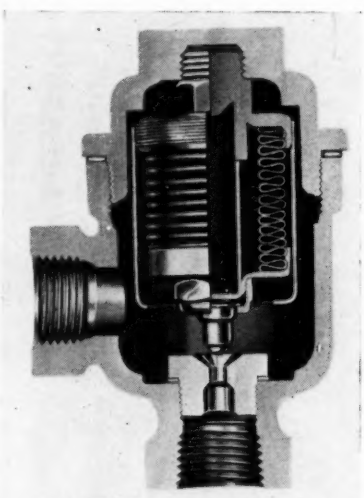

Fig. 10. Balanced-pressure expansion trap.

The expanding element in the balanced pressure trap, Fig. 10, is a corrugated tube which is filled under vacuum with a liquid and sealed. The liquid must have a boiling point which is lower than water, and a liquid with a boiling point about 25 deg. F. below that of water is usual. The corrugated tube is fixed to the body of the trap at the top, and it is provided with a ball valve at the bottom. Condensate enters the trap through the side connection and passes through the trap. As the temperature of the condensate rises the liquid in the corrugated tube expands, which causes the valve to move slightly towards its seat. Eventually the liquid boils and the pressure of its vapour extends the tube sufficiently to close the valve. As the trap cools the vapour in the corrugated tube condenses, reducing the pressure in the tube which then contracts to discharge more condensate.

Since this trap depends for its operation on the pressure difference developed between the vapour in the corrugated tube and the steam pressure outside the tube, it is self-adjusting and will operate under variations in steam pressure. But if the steam is superheated the pressure differences will become excessive, and the expanding element will be damaged. The trap is very compact, and it has a large discharge capacity for its size; it will not withstand water hammer. It should not be fitted at the end of a long length of horizontal pipe for the reason mentioned above under the thermodynamic trap.

Since there is a certain delay before condensate cools sufficiently to operate an expansion trap, condensate from these traps cannot be discharged at steam temperature, and they are not suitable for use in cases where condensate must be discharged immediately, such as on unit heaters. They are fully open when cold and

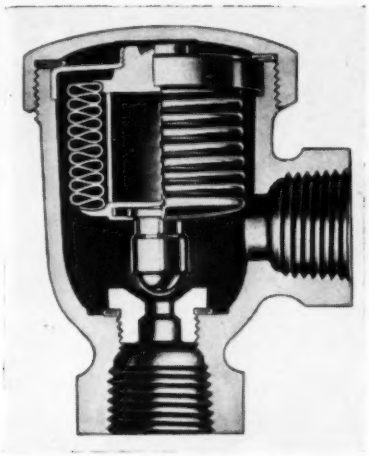

Fig. 11. Automatic air vent.

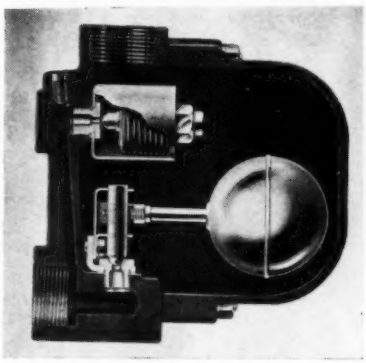

Fig. 12. Plain float trap with internal air vent.

will therefore discharge air from equipment on starting up.

Incondensible gases

Incondensible gases are usually referred to as air and must be removed from the equipment. Float traps and open bucket traps will not discharge air. The other types of trap described will discharge air, but in some cases their capacity to discharge it may be too low. One method of venting the air is to fit hand-operated valves, which are opened when the equipment is started up and closed when all the air is thought to have been released. The valve is opened again if the operator notices that the process has slowed down. This procedure is quite unsatisfactory.

The best method for the removal of non-condensible gases is by means of thermostatic air vents (Fig. 11). These are similar in operation to balanced pressure expansion traps. Where the steam is superheated a thermostatic vent working on the liquid expansion principle is used. Some steam traps are available which have automatic air vents built into them (Fig. 12). An inverted bucket trap incorporating an automatic air vent is also on the market. It should be remembered that traps with built-in air vents working on the balanced pressure principle are unsuitable for use with superheated steam. It is also important to choose the right position for fitting air vents to equipment, and information on this is available in standard works.[2, 3]

Frost

With the exception of the thermodynamic trap all the mechanical steam traps described can be damaged by frost. Expansion traps and the thermodynamic trap will not freeze if they are installed in positions where the condensate can drain freely away, and the condensate cannot freeze at some point in the condensate drain line. Traps which can freeze should be lagged. If plant is shut down in periods of prolonged frost, lagged traps can freeze unless they are otherwise protected or drained. Inverted bucket traps should be lagged at the sides and bottom; the top should be left bare to allow the steam which bleeds from the bucket to condense.

Trap selection

The universal steam trap does not exist, so steam traps must be selected after careful consideration of the work they have to perform. Some factors which have to be taken into account are: Maximum rate of condensate formation; pressure under which the trap will operate; pressure and load variation, if any; and the amount of air likely to be present. If noise will be a nuisance, traps which operate intermittently are generally ruled out. Where a corrosive condensate must be handled, traps with corrugated tubes are unsuitable and a trap must be chosen which is available in a corrosion-resistant material. In cases of doubt in the selection of a suitable trap, manufacturers should be consulted.

Maintenance

In many works steam traps are the most neglected pieces of equipment as regards maintenance. When a trap ceases to function it is sometimes bypassed and maintenance is delayed. This is one of the reasons why bypasses should not be fitted into the system unless it is really necessary. The trap is sometimes blamed if it will not work when the real trouble is that it is installed in a system where it is impossible for it to work. If a steam trap does not appear to work, it should be remembered that reputable manufacturers do not put unworkable steam traps on the market and the installation details should be checked.

It is advisable to fit strainers into the lines before all steam traps and to inspect these strainers periodically and clean them. A frequent check should be made on all steam traps to see if they are operating satisfactorily. The check may be one per week to once a month, and it may be carried out by fitting test valves or sight glasses into the system. Traps should be opened up yearly to inspect the mechanism and replace worn parts.

Acknowledgment

The author thanks Mr. W. M. Barber of Spirax-Sarco Ltd. for providing information about the thermodynamic steam trap.

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In the foregoing article, Fig. 2 is reproduced by courtesy of Hopkinsons Ltd.; Figs. 3, 5, 6, 9, 10, 11 and 12 by courtesy of Spirax-Sarco Ltd.; Fig. 4 by courtesy of Drayton Regulators Ltd.; while Fig. 8 is after O. Lyle, ' The Efficient Use of Steam,' and is reproduced by permission of the Controller of Her Majesty's Stationery Office.

Steering committees for new British laboratories

A change of organisation affects two D.S.I.R. laboratories—the new Warren Spring Laboratory, Stevenage, and the recently renamed National Chemical Laboratory (see CHEMICAL & PROCESS ENGINEERING, 1958, **39** (8), 265). This involves the setting up of small steering committees to bear responsibility for the research programmes carried out. Under the former system research boards were responsible to the Research Council, but there was not necessarily any common membership. An essential feature of the new arrangement is that the steering committees are full committees of the Research Council, and that there will be a direct link between the two bodies because the chairmen of the committees are members of the Council.

THE CHANGING PATTERN OF GAS MANUFACTURE

Part I—The Raw Materials Question

By A. R. Myhill, F.R.I.C., M.Inst.Gas E., M.Inst.F.

Until very recently, the manufacture of town gas could well have been described as a remarkably conservative industry producing the bulk of its products by methods differing but little from those used by Murdoch over 150 years ago. Factors influencing supplies of raw materials, however, coupled with proved possibilities shown by research, are now showing the way to a new pattern of the gas industry which will employ entirely new methods of manufacture and supply.

METHODS of manufacture and supply of town gas in different countries vary greatly according to the availability of their particular raw materials, both indigenous and imported. Fuel policies in general are not only regional, but temporal, that is to say they must be related to both place and time, and are affected by many outside factors such as depletion of old resources, or discoveries of new resources, or by the impact of new industries.

The picture of the future of the gas industry in all countries will reveal a dynamic phase which, notwithstanding its recourse to new materials and methods, can only change gradually, because it must be always mindful of changing conditions in other fields.

The coal problem

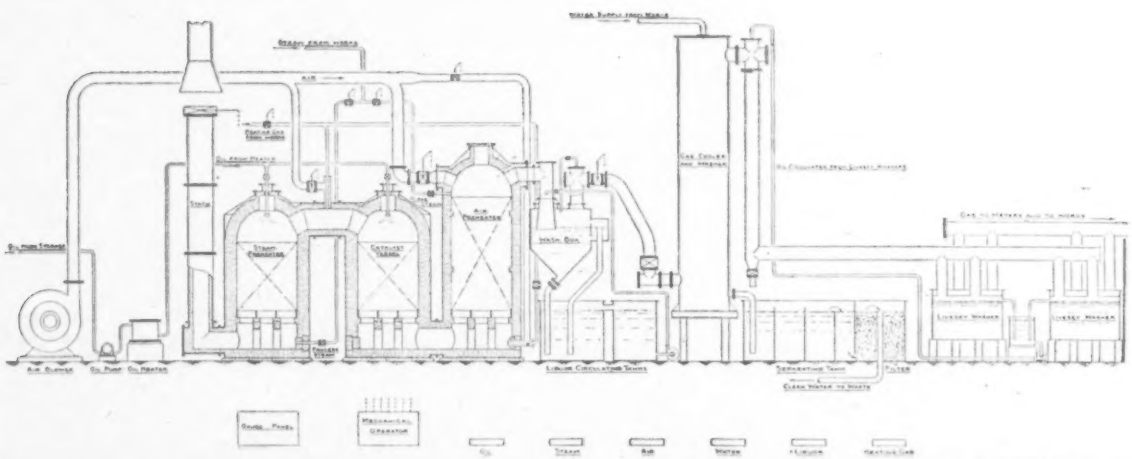
In Britain, base-load gas is made almost entirely by the carbonisation of coking coal and, since coke is a necessary accompaniment to gas, gas manufacture is a two-fuel industry. Its economics are therefore closely bound up with the maintenance of a supply of coke of a quality which is acceptable to the purchaser. In recent years, the coke position has become increasingly serious on account of the difficulties experienced in obtaining sufficient quantities of coal, at reasonable prices, of the special types suitable for carbonisation.

Of the 200 to 220 million tons of coal mined annually, about 75 million are suitable for the production of gas and coke. Gas works take 25 to 30 million tons, and coke ovens somewhat less, making a total of about 70% of the available material.[1, 2]

During the last decade, however, there has been a progressive increase in the usages of such coals, amounting to a cumulative rate of 3% p.a., so that ' at the present rate of expansion, the total annual tonnage of suitable carbonisation coals now being mined will be absorbed in less than 20 years.'[2] Unfortunately, large quantities of carbonisation coals continue to be used for purposes unconnected with the manufacture of gas or coke, as, for example, steam raising and domestic fires.

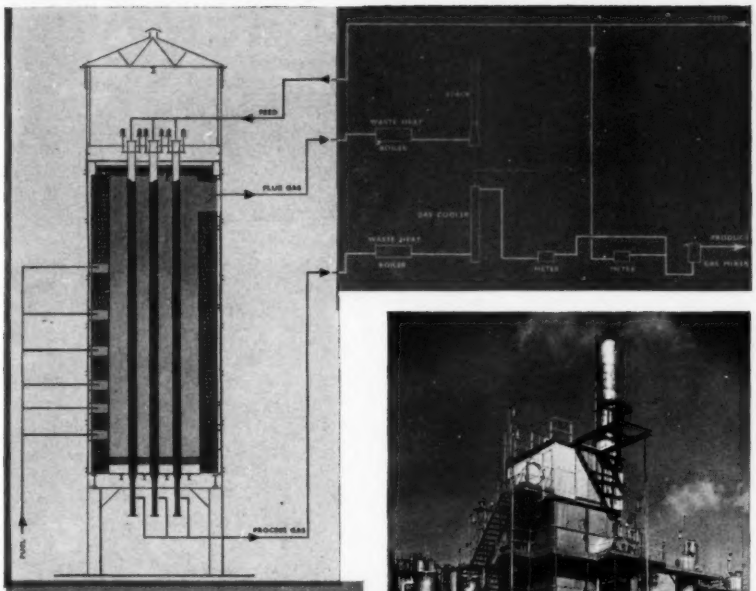
Advances in carbonising practice

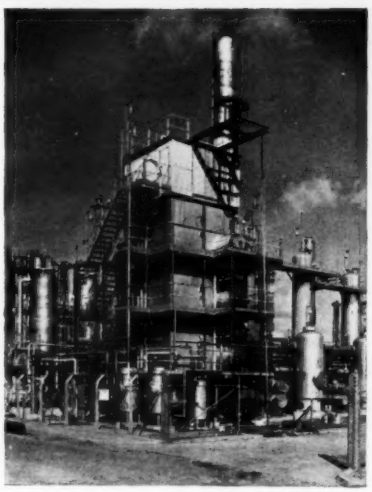
Coal carbonisation, taken in con-



[*Courtesy: Institution of Gas Engineers*

Fig. 1. Diagrammatic arrangement of oil gasification plant at the Sydenham works of the South Eastern Gas Board.





Courtesy: Power-Gas Corporation Ltd.

Figs. 2 and 3. *Above:* **Arrangement of a Power-Gas/Hercules unit for producing fuel gases of varying calorific values and varying densities, in particular for producing gas of the same specific gravity and calorific value as town gas.** *Right:* **Furnace of a Power-Gas/Hercules hydrogen plant recently installed.**

junction with the combustion of its products in modern appliances, represents the most thermally efficient method of releasing the potential energy of our indigenous fuel resources that has been devised up to the present. Whatever may be the ultimate policy, decided by changing circumstances, it would appear certain that for many years to come the gas industry will remain largely a two-fuel one.

The Clean Air Act calls for the production of greatly increased quantities of solid smokeless fuel and, while part of this will be forthcoming from low-temperature carbonising plants operating mainly for this purpose in conjunction with chemical manufacture, a large proportion will still have to be in the form of gas works coke. Gas retort plant will therefore continue to be erected, although the high capital cost, together with the hesitance engendered by the implementation of new methods of complete gasification, will doubtless slow up the building programme. It is unlikely that any new advances in carbonisation will include radical alterations in plant design, and operational practice will be directed towards further increases in ease of working, increased thermal efficiency, and higher outputs per unit.

Proposals for extending the range of coal types which can be used for carbonisation have been under consideration for many years.[5] In the coke-oven industry, the use of blends of caking and non-caking coals to produce hard coke is now common practice, but for gas works the added expense of providing crushing and blending machinery, storage hoppers, and mechanical handling plant, together with the uncertainty of obtaining deliveries of the required coals, has made coal blending uneconomical except in special cases.

An important development in carbonisation is the adoption of the 'carrier-gas' process for continuous vertical retorts. In continuous vertical practice, steam is admitted continuously at the base of the retort for the purpose of adding controlled quantities of water-gas by reaction with part of the coke.

The carrier-gas process involves injecting into the retort a gas of low calorific value (usually water-gas made in external plant), without the normal admission of steam.[3] The effect is to increase the possible carbonising rate up to about twice that obtained in normal high-temperature practice, due to augmentation in heat transmission rate into the charge. This is brought about by internal heating from the carrier gas which passes through the hot coke zone. There is also an increase in the porosity and combustibility of the resulting coke.

The overall efficiency of gas production is, however, lower than that of normal carbonising practice on account of the comparatively low production efficiency of the water-gas used, but the process is useful where it is desired to increase the gas and coke yields from installations of limited size. By working at temperatures lower than normal, and operating at normal (or even higher) carbonising rates, it is possible to make special, easily combustible coke for domestic use. This opens out encouraging prospects for the manufacture of increased quantities of solid smokeless fuel without the co-production of embarrassing quantities of surplus gas. The North Western Gas Board is now marketing a new fuel (*Phimex*) made in this manner in continuous vertical retorts at a temperature of about 750°C. Other gas boards have also started manufacture on similar lines.[4, 5]

Gas-making from coal without production of coke

Methods of total coal gasification employed up to recent times include two-stage cyclic processes such as water-gas manufacture, in which the coke from carbonising plant is used as additional gas-making material in a separate generator, single-stage cyclic processes using coal, as in the Gaz Integrale and Tully systems, and continuous systems making producer gas.

Single-stage processes have the advantage of being able to use non-caking coals. These methods, however, yield low-grade gas which, in itself, is unsuited to the production of base-load town supply.

The picture, however, is changing, and the development of completely new methods of coal gasification, of proved high thermal efficiency, over a wide range of gas quality, presents a much more favourable aspect.

These methods will be discussed in Part 2 of this article.

Oil for gas-making

Oil has been used for making gas in Britain for over half a century, but has been restricted to supplying peak-load carburetted water-gas for augmenting the normal coal-gas supply. The establishment of the oil refinery industry in Britain, processing over 30 million tons of crude oil per year, has led to increased interest in this sub-

ject, but, since gas oil is an expensive material, attention is being directed to the use of residual oil in modified forms of carburetted water-gas plant.

The main alterations consist of means for the avoidance of troubles due to partial blockage of the plant by carbon deposition. This is achieved by modified carburettor design in which cracking takes place in an open vessel without chequer filling.

Several installations have been working on these lines during the past few years, but at present prices there has been no very considerable saving in the cost of gas-making after taking into consideration the costs of converting existing carburetted water-gas plants. The scheme has, however, useful potentialities in extending the range of oil types which can be gasified.

Much more promising methods of gasifying heavy oil are those employing catalytic cracking. These methods, unlike the carburetted water-gas process, do not necessitate the use of coke. Two such systems now operating on the commercial scale in Britain are the *Segas* and O.N.I.A.-G.E.G.I. processes. These employ very similar principles in which oil is cracked in the presence of steam at temperatures lower than those used in non-catalytic processes. The catalyst in the *Segas* process is of the lime-magnesia type and, in the O.N.I.A.-G.E.G.I. system, a nickel catalyst is used.

The plant layout is not unlike that employed for making carburetted water-gas, except, of course, that the blue-water-gas generator using coke is absent. It is, in fact, a relatively simple matter to convert an old c.w.g. plant to catalytic oil cracking.

The process operates on the 'blow-run' principle. During the 'blow' period, air is supplied for heating the cracking chambers by combustion of either oil or gas at appropriate positions. During the 'run,' or gas-making period, oil, sprayed on to the heated brickwork of the preheater and catalyst vessel, is vaporised and, together with superheated steam, undergoes cracking reactions in its passage through the catalyst bed. Plant conditions are readily controllable to make gas of the required characteristics for town supply.[6, 7, 8] Fig. 1 shows a diagrammatic arrangement of the *Segas* catalytic oil gasification plant at the Sydenham works of the South Eastern Gas Board.

Tail gases from petroleum refineries

The establishment of oil refineries in Britain has led to the production of large quantities of surplus gas from cracking processes. Although much of this gas is being used for heating purposes at the refineries, and a considerable amount sold in liquefied form in cylinders, there are still very great volumes for which no market has yet been found, and this excess is being burnt to waste. The gas industry is planning to augment its future supplies from this source, and several gas boards have already entered into contracts to take tail gases. Among these may be mentioned 17 million therms of refinery gas (equivalent to 13 million therms of town gas) p.a. for supplying Southampton on a 10 years' agreement with the Esso Petroleum Co. at Fawley, and the laying of a pipeline by the North Thames Gas Board from the Shell refineries at Shell Haven to supply 25 million therms p.a. at Romford.[9]

Because of its composition, calorific value (1,200 to 1,600 B.Th.U./cu.ft.), specific gravity, and combustion characteristics, refinery gas is unsuitable for direct use in normal gas-consuming appliances. Two methods are applicable for dealing with this problem. The first consists of simple dilution to the required calorific value (450 to 500 B.Th.U./cu.ft.) with producer gas, blue-water-gas or other low c.v. gas. Such a procedure, although 100% thermally efficient, is only applicable to mixtures containing low proportions of high c.v. gas, and cannot therefore deal with large outputs from the refinery. The second method is to 'reform' the gas by cracking the hydrocarbons in the presence of steam, with or without a catalyst. This may be done by continuous or 'blow-run' processes, and has the advantage of producing a wide variety of gases which are suitable for mixing in any proportion with coal gas. Although not so thermally efficient as simple dilution, it is possible to reach an overall thermal efficiency of 85 to 86%, with a cracking efficiency of 73 to 75%. This is achieved by reforming down to 300 B.Th.U./cu.ft. and cold-enriching to 450 to 500 with some of the original gas. Reforming can be carried out in modified water-gas plants or in catalytic oil-gas plants as the O.N.I.A.-G.E.G.I. installation at Romford.[10]

A continuous system is supplied in Britain by the Power-Gas Corporation of Stockton-on-Tees. The plant is shown in Figs. 2 and 3 and will deal with either high-c.v. gas or with liquid hydrocarbons, to make a final gas over a wide range of calorific values. It employs a nickel catalyst.

Natural gas

Gas found in pockets in association with oil deposits is found in many parts of the world. In the U.S.A., over 90% of town gas is of natural origin. The gas as received from the wells has a calorific value of 1,000 to 1,300 B.Th.U./cu.ft., and may be used directly in appliances made with special burners, or may be reformed to make gas of 450 to 550 c.v.

In Britain there are no significant deposits of natural gas of petroleum origin, but experimental work is being carried out to assess the practical economics of importing natural gas in liquefied form from America in specially constructed ocean-going vessels (see A. R. Myhill, CHEMICAL & PROCESS ENGINEERING, 1958, **39** (1), 24-26).

Methane drained from coal mines is a natural source of future gas supplies, and arrangements have been made between the gas boards and the National Coal Board with this end in view. In this way, not only is use made of a material which would otherwise be wasted, but safety conditions in the mines are also improved. Methane recovered from the collieries at Duffryn Rhondda, Avon, and Glyncorrwg is pumped at the rate of a million cubic feet per day to Aberavon, and is equivalent to twice this volume of ordinary coal gas.

To withdraw the gas from the strata surrounding the workings, boreholes about 100 to 120 ft. long are drilled into the roof above the wastes behind the coal face. The holes intercept and collect the gas before it can enter the ventilating air current, and have a productive life of about three months, after which they are sealed off.

Part 2 of this article will deal with the principles upon which the new gas manufacturing methods are based, and will give special attention to the Lurgi process and processes using powdered coal, concluding with a discussion of probable future trends.

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Pneumatic Handling of Bulk Materials

By W. Farnworth, B.Sc.(Eng)., A.M.I.Mech.E.
(*Simon Handling Engineers Ltd.*)

Pneumatic conveying, the carrying of material in suspension by an air stream moving in a pipeline, can be applied to most granular materials. Materials which have been successfully handled include coal (in sizes from 2½ in. downwards), grain, ash, grit and a large number of powders and chemicals.

As each material presents its own problems and each installation is made to suit particular requirements there is an extremely wide variation in the design details of pneumatic conveyors. The majority of them, however, can be grouped under three headings, *viz.* the suction (or vacuum) system, the blowing (or pressure) system and the combined suction-blowing system. A fourth system is the air-slide or fluidised conveyor which, although very efficient and economical, can be satisfactorily used in only a few cases compared with the other three systems, because it depends for its operation upon the fluidisability of the material and a drop in height between the collection and delivery points.

The first three systems operate by virtue of a pressure drop in the pipeline between the collection and delivery points. There are, however, cases in which the suction system is the only practical choice, for example, in the discharge of bulk materials from a ship's hold.

With the exception of the air-slide, all pneumatic conveyors have the same essential features, *i.e.* each comprises an air pump, a feeder through which the material enters the system, a pipeline through which the air flows and conveys the material, a separator in which the material is separated from the air and a discharger which extracts the material from the system. The air-slide conveyor consists of an air pump, an inlet feeder and the slide itself which usually discharges direct into a hopper. The slide is merely a duct which is divided into an upper and a lower section by a porous membrane. The material is fed in at one end of the upper section and air is admitted to the lower. The air passes through the membrane and fluidises the material so that, by providing a slight downward slope, a rapid material flow-rate can be obtained.

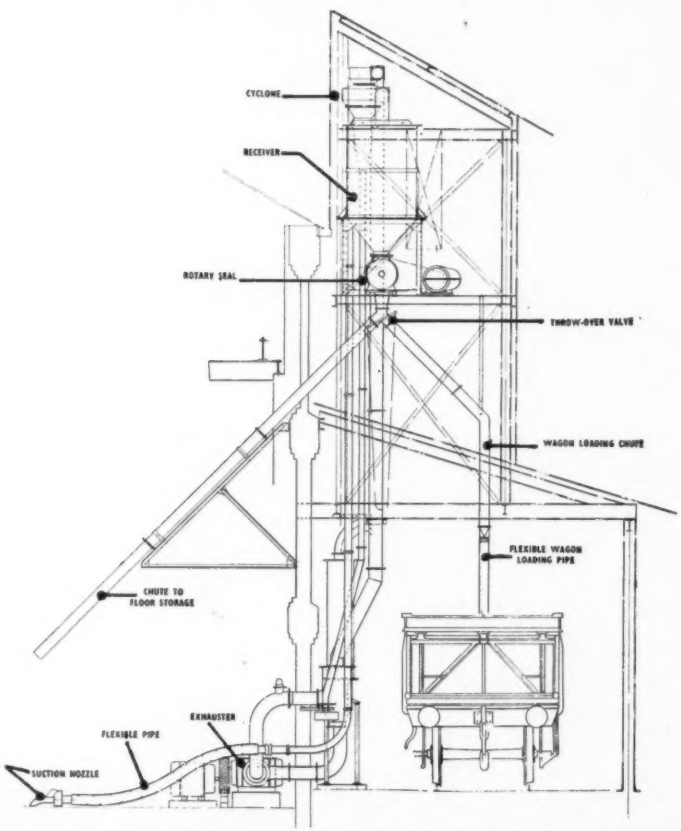


Fig. 1. Handling, loading and storage plant for sulphate of ammonia.

Advantages

Perhaps the most important advantage of a pneumatic conveyor is its flexibility. The pipeline can follow any route without taking up a lot of space or interfering with existing structures, and it is easily installed. The power unit need not be in any particular position relative to the conveyor and its site can be chosen for greatest convenience. The development of selector valves has made it possible to install, comparatively cheaply, complex distribution systems with complete remote control if required.

A properly designed pneumatic conveyor eliminates dust nuisance and is also self-cleaning.

Typical installations

The layout of a pneumatic handling plant working on the suction system is shown in Fig. 1. The material is ammonium sulphate and the plant is capable of handling 5 tons/hr. The ammonium sulphate is delivered at one point within the storage building and the plant is used both for distributing the material over the storage area and for loading into rail wagons.

The air pump is located at ground level and draws in air which enters the conveying system at the suction nozzle. The suction nozzle is attached to a flexible pipe whose length can be adjusted as required. As the air passes into the system it picks up material and carries it along to the receiver where it is separated from the air and discharged, through a motor-driven rotary seal, to either the floor storage distribution chute or the wagon-loading chute. The dusty air from the receiver passes into the cyclone where the separation process is completed, the clean air passing through the exhauster to atmosphere and the material falling down a chute to a sacking-off point.

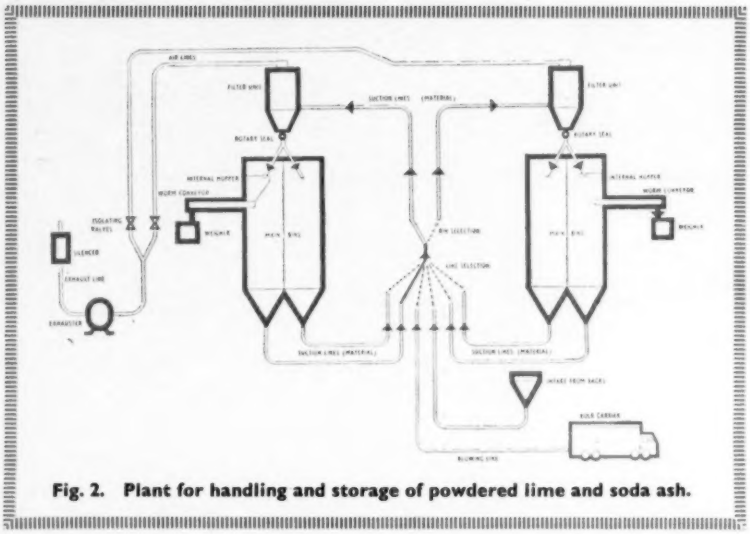


Fig. 2. Plant for handling and storage of powdered lime and soda ash.

Fig. 2 shows the flow diagram of a plant for handling and storing powdered lime and soda ash, the material flow-rate being 10 tons/hr. Three of the four main bins are normally used for storing lime, the fourth is for soda ash. In the soda ash bin and in one of the lime bins there are internal pocket hoppers feeding worm conveyors which operate in conjunction with a weigher. The required weighment is selected at a central control panel and from then on the weighing operation is automatic.

The plant operates on the suction system and the separator is a combined filter and receiver, the filter elements being tubes of porous plastic giving a very high degree of filtration. The tubes are arranged in sections so that one section at a time can be isolated and cleaned. The cleaning operation is automatic and is effected by admitting high-pressure air to the tubes in the opposite direction to the flow of conveying air. The filter-cleaning air is supplied by a small compressor which also provides air for the operation of several control valves.

The bins are arranged in pairs with one separator to each pair, the material being discharged through a rotary seal into the bin selected. The airline required is selected by manually operated valves situated close to the air pump. The incoming material can be directed to either separator by changing over the upper end of a flex fitted with a quick-acting coupling. The lower end of the flex is coupled to a swivel section which can be connected to any one of six lines—one from the bottom of each bin, one from a ground-level intake hopper and one from a bulk wagon connection point.

The incoming material is conveyed —by suction from the intake hopper, by blowing from the bulk waggon—to the selected bin for storage and is then drawn off and conveyed to a pocket hopper as required.

The bulk wagon is an interesting application of the blowing system and incorporates fluidised conveyors. The

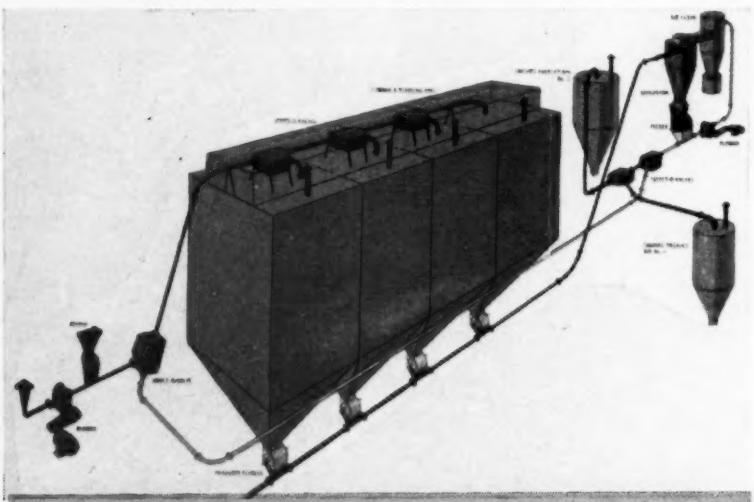


Fig. 4. Conveying, storing and blending. (*Left*): Blower and feeder. Selector valves at three pipe junctions, three more above storage and blending bins. (*Right*): Blower, feeder, separator, air filter and two finished-product bins.

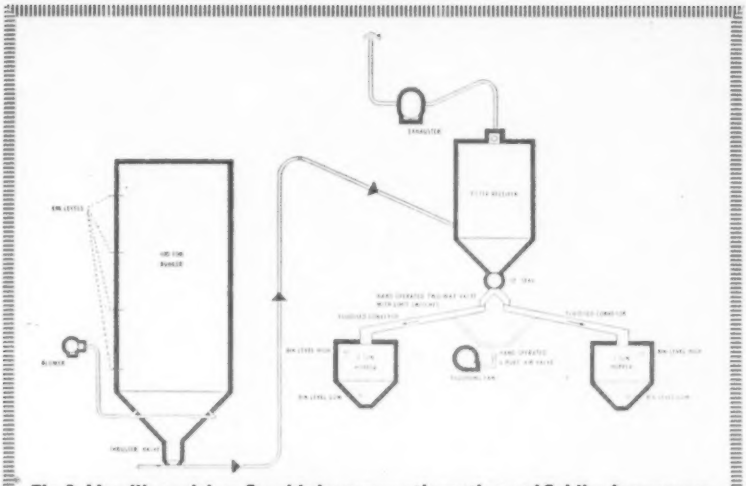


Fig. 3. Handling calcium fluoride by pneumatic suction and fluidised conveyors.

light alloy body contains a hopper along the bottom of which run fluidised conveyors with a slope from the front to the rear of the vehicle. The material flows down these conveyors and discharges into rotary seals which are designed so that each pocket in turn forms part of the conveying line, the air flowing in a direction parallel to the axis of rotation of the seal. The conveying air and the air for the fluidised conveyors are supplied by separate blowers, both of which are driven by a power take-off from the engine of the vehicle.

Another mobile handling plant makes use of the suction-blowing system. Although originally designed for grain this plant can be used equally well for other materials. Its capacity when handling wheat is 30 tons/hr. with 100 ft. of suction and 100 ft. of blowing. The air pump is driven, as is the rest of the machinery, by a power take-off from the gearbox of the vehicle.

The material is conveyed by suction from the collection point and passes into a receiver which is built into the vehicle. Here the bulk of the material is separated from the air and passes through a rotary seal which discharges to the pressure side of the pump. The dusty air is made to pass through a cyclone which is fitted inside the receiver. The dust is collected by the cyclone and rejoins the bulk of the material in the seal at the bottom of the receiver. The clean air passes through the air pump and mixes, once again, with the material as the latter is discharged from the rotary seal. The material is thus blown through pipes to its destination. The pipes, which are of both the rigid and flexible types and fitted with quick-action couplings, are stowed with their supporting trestles in the rear of the vehicle.

The flow diagram in Fig. 3 is for an installation handling calcium fluoride powder. The material is stored in a bunker of 100 tons' capacity and the pneumatic handling system is used to feed batch hoppers, each of 2 tons' capacity. A suction line draws material from below the storage bunker into a receiver fitted with a filter unit similar to the one described previously. From the receiver the material passes through a rotary seal into two fluidised conveyors which lead directly to the batch hoppers. When the material level reaches the 'high' indicator in the batch hopper the electrically operated valve below the main bunker is automatically closed and shuts off the feed. The remaining space in the batch hopper is sufficient to accommodate the material still in transit. To facilitate flow from the main bunker the hoppered bottom is fitted with porous pads through which air is passed to fluidise the material. This ensures a steady flow of material from the bunker outlet and prevents 'arching' of the material in the bunker.

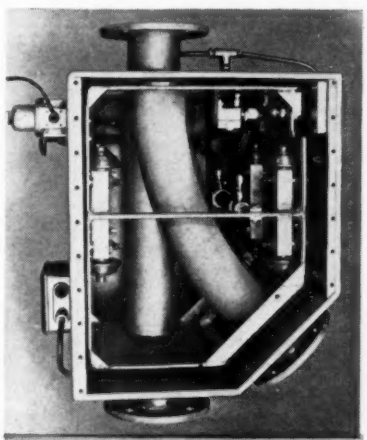


Fig. 5. 'Select-O-Valve' with cover removed to show internal construction.

A typical installation using both a blowing system and a combined suction-blowing system is shown in Fig. 4. The purpose of this plant is to convey, store and blend different materials and selector valves (Simon *Select-O-Valves*) are used to obtain the required number of conveying routes. The construction of a *Select-O-Valve* is shown in Fig. 5. The casing is provided with three flanged ports to suit the conveying pipes and two pipes are fitted to a carriage which can take up either of two positions within the casing. The ports and pipes are arranged so that in one position of the carriage the material is conveyed straight through the valve and in the other it is diverted along another route. A positive seal is made at each joint by inflatable jointing rings. The pressure in these rings is released before movement of the carriage and automatically reapplied in the new position. The *Select-O-Valve* is pneumatically operated and can be remotely controlled either by pneumatic or electrical equipment.

The material is initially fed into a blowing line and conveyed to the selected bin for storage. It is then drawn off, as required, from the bottom of the storage bin into a suction line. If blending is required this is done by feeding the different materials simultaneously into the suction line so that the materials are mixed as they are conveyed, their proportions being controlled by the rates of feed into the line. Infinitely variable speed drives fitted to the rotary feeders below the bins enable accurate blending of any proportions to be obtained.

After separation the air is filtered and passes through the pump to rejoin the material which is fed through a rotary seal below the separator. The material can now be conveyed to process hoppers, finished product bins or back-to-storage bins.

The operation of the whole conveying and blending system can be controlled remotely from one panel with a mimic diagram. Interlocking of the various components enables fool-proof working of the system to be achieved.

Mechanical Handling in the Chemical and Allied Industries

By F. T. Day

The efficient and economic handling of the wide variety of materials and products encountered in the chemical and allied industries is a subject which needs careful and detailed examination by the responsible executives. There are, however, some cardinal points which have an application to the handling of materials in general, and these are reviewed in the following article.

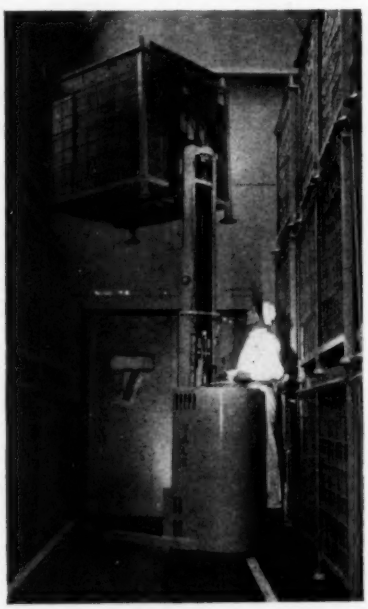
MAKERS of the various mechanical handling devices have studied the special requirements of all important trades, and most are able to provide appropriate equipment for handling drums, barrels, tins, cans, canisters, crates, containers, cartons and other packages of various sizes and shapes. Consultation with the equipment makers will ensure the most suitable appliance and, very often, demonstrations can be arranged under field conditions. The main advantages of mechanical handling may be listed as follows:

(1) Reduction of cost and time in handling bulk supplies of materials to place of store, from storage to place of conversion or dispatch. The faster movement of supplies throughout the factory or works speeds up production and avoids any waiting time at machines and flow line.
(2) There is far less likelihood of damage to corners and edges of packed or canned products.
(3) Certain types of liquids may remain in bulk storage until required for packaging in small containers for dispatch.
(4) The box and flat metal or wood pallet method of movement and storage and the use of fork-lift trucks capable of working in very narrow aisles ensure full use of available floor space.
(5) Fatigue of workers handling goods is lessened.

Fundamentals of materials handling

Materials or goods of any kind, ready for sale, dispatch or processing, should not be moved or handled until they are required for converting, filling, processing or the final operation of delivery. The requisite quantity should be conveyed to the place of usage, flow line bench or machine, when they are required. This avoids 'waiting time.' Operatives should not leave production, processing or converting plants to fetch individual supplies of raw materials.

Where new mechanical handling devices are installed, it must be someone's duty to ensure that the operatives concerned with them fully understand their scope and capacity. The more materials handled at one time, within the limits of the device, the lower the cost and the more efficient the production line.



Bin loads are stacked from an aisle only 6 ft. wide with this electric truck made by Yale & Towne Ltd.

The link between store, production units and operators should be studied, as factory efficiency is only as high as materials or mechanical handling methods will allow it to be.

It may be taken into account that floor space and walls have a third-dimensional space value and this may be considered with the aid of an expert in terms of cubic feet and not merely square feet. The planning of floor space in an endeavour to get the utmost value out of it helps to cut costs and assists in the passage of raw materials from store to place of usage and dispatch. This should be considered part of the actual process of manufacture.

Planning for mechanisation

The initial intake of raw materials, their storage, their transference to the place of usage, their processing, the packing or packaging and the final dispatch or delivery should be approached at the onset when fresh plans are being worked out, as a problem of material mechanisation as opposed to manhandling.

Every allowance should be made for very bulky items used in the processing or packaging of products, such as boxes, cartons, caskets, cases and bins; where possible, they should be made collapsible, thus taking up less floor space when not in use.

Installation of a simple gravity roller track can speed up the movement not only of raw materials but also of returned empties and other drums and containers. Many of these items are manhandled even in the larger organisations. Often some prejudice may be found among those who have to handle

Drums being handled into position with a Lansing Bagnall fork-lift truck.

them, but this can be broken down by pointing out the important arguments relative to fatigue and labour saving, cutting costs and time or the introduction of some small incentive bonus scheme.

Bins, pallets and trays

There are a large variety of wood and metal trays, stillages or pallets, bins, wire crates and trays suitable for the handling, storage and conveyance of every kind of drum, tin, container and made-up unit. This method is proving itself useful in many trades, particularly where bin-loads are stacked, often in narrow aisles. Bins, trays and pallets are easily moved with hand-controlled or electric truck of the fork-lift type, most of which have capacities of handling of 2,000 and 3,000 lb. weight and upwards. The use of a pallet or bin in conjunction with a truck to suit the volume of work and local conditions is to be recommended for the flexibility of operation that may be obtained and for the full use which may be made of the third-dimensional space in storage, while stock checking is another advantage to be gained.

Pallets vary from simple, low trays of wood and metal to a specially designed bin for storage or conveyance of raw materials or finished products. Many unit loads may be dispatched or delivered in their palletised form, the bin or pallet being returnable by arrangement.

Types of bin and pallet

There are single- or double-faced, two-way, four-way or eight-way entry pallets and these may all be designed for use with hand pallet or bin trucks as well as the power-controlled fork-lift truck. Some forms of open-framed pallets are called stacking frames, as they consist virtually of a base member to carry the load and vertical members which enable the pallets to be stacked without the goods being crushed.

There are box pallets which have a floor or base, plus a side and ends which may or may not be detachable. Such box pallets are used to hold articles of a loose variety of the type which could not readily be stacked and would otherwise prove difficult to handle. Bins and pallets are made in varied sizes to suit various industrial usages. However, in recent years, some degree of standardisation has been planned in order to meet the sizes of transport vans, railway wagons and containers. Very soon it will be the custom to specify goods packed and dispatched in some form of pallet or bin in much the same way as many products are delivered from the large supplier of raw materials in bulk form. The idea has been mooted of a pallet pool and, when this stage has been reached, real palletisation of goods will have arrived in such a way that it will assist all those in the chain of supply, production and delivery of merchandise.

This hand truck by Conveyancer Fork Trucks Ltd. is used for lifting barrels and drums.

However, each manufacturer must plan his own storage and handling plans, whatever else may be developed from the standpoint of transport systems and progress. There can be no general solution of materials handling problems, the size of the product, the nature of the filling or processing operations, the weight of the merchandise handled, the kind of product, and the distances to be travelled during conversion being some of the important factors which have an influence upon the handling system.

In many cases, if the pallets or bins are stacked away in rotation or numbered suitably, old stocks can be used first. All materials are kept off cold stone floors by use of the pallet and this may be important in some products handled in the chemical and allied trades.

Bin lifters, tilters and stackers

Whatever the size of the organisation there is, in most warehouses, a place for the truck, hand- or power-operated bin lifter and barrel tilter and other similar devices used for conveying limited loads or units from store to bench or transport. Many of the current lifters and tilters are fitted with moulded rubber cushion, sorbo or pneumatic and unpuncturable semi-pneumatic wheels in order to avoid undesirable noise or damage to wooden floor surfaces. They will handle drums, rolls, cans, tins, barrels, wire mesh bins and pallets in confined spaces, moving goods from one department to another through low doorways.

Fork-lift trucks

Some reference has been made to this important piece of equipment which is constantly showing up in many plants, being introduced to assist in materials handling of various kinds

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Conveyors for Bulk Materials

THERE is a great variety of elevators and conveyors for handling materials in bulk and in many cases the design takes into account special corrosion or temperature problems or the need to control friable materials. Some recent developments of interest to the chemical and allied industries are discussed below.

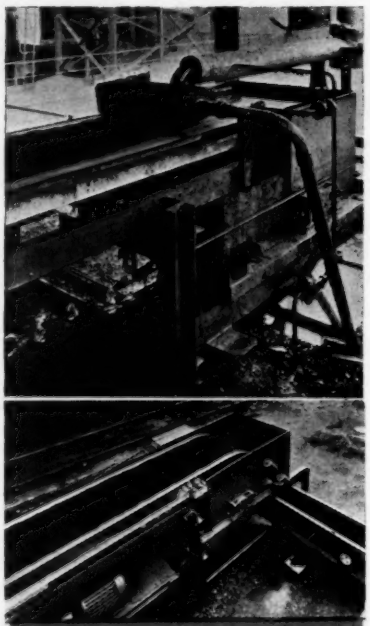
'Water-bed' conveyor

A type of conveyor that is being put to increasing use is the steel-band conveyor, which is particularly valuable where there are heat-exchange problems, owing to the good conductivity of the steel band. Originally materials could be dried or cooled by applying heat or water sprays to the underside of the band, but a further advance has been made with the introduction of the water-bed conveyor. In this, the steel band, instead of passing over rollers, passes over shallow water tanks which extend almost the full length between the terminal pulleys. For light duties the edges of the water tanks are fitted with brass or lignum vitae strips with vee-shaped brass bars across the width, but for heavy duties the water tanks are fitted with a number of stainless-steel spindles and plastic rollers for supporting the band.

The water in the tank is circulated either from a main, or by means of small pump units, the pressure tending to lift the band so that the whole area of the band is in contact with the cooling water, which overflows into a collecting channel. The steel band is frequently enclosed in a chamber or ducting, through which cooled air is pulled in a contra-wise direction to the travel of the conveyor, thus giving additional cooling on the top surface of the material being conveyed. When cooling liquids, the edges of the steel band are fitted with strips such as rubber, to form a trough.

Ordinary domestic water supply or well water is generally used, at a temperature of about 55°F., but if the heat transfer required is very high, water from a refrigeration plant is used.

Materials which have been cooled on steel bands include gelatine, glue, synthetic resin, metasilicate of soda, sulphur, soap powder, etc. A further interesting application is for the solidification of pitch, and Sandvik Steel Band Conveyors Ltd. report that two units for this purpose have been supplied to tar distillation plants and four more are on order.



Sandvik steel-band conveyor handling pitch. In the upper picture, pitch is being fed on to the conveyor *via* a special feeder, while in the lower picture, it is emerging at the other end in flake form.

There are two types of units for handling pitch. In the first, the pitch is fed on to the steel band, the underside of which is cooled with water, whilst in the second case the steel band which carries the pitch is submerged in water. The initial temperature of the pitch varies from 150 to 300°C., the softening point varies from 80 to 110°C. depending on the ring and ball test and the capacity varies from about 1½ to 4 tons/hr.

Channel-belt conveyor

A useful conveyor for handling bulk materials is the *Capacity* channel-belt conveyor, which is of moulded construction and can best be described as a flattened tube with the top section removed, leaving a flat base and two radiused side walls. Introduced by Rownsons (Conveyors) Ltd. as an alternative to the troughed, idler-belt conveyor, it is available in conventional materials, namely pure or synthetic rubber and plastic, including food quality and heat-resistant grades, all reinforced with canvas or nylon.

Operation is similar to that of the standard flat-belt conveyor, discharging over the head pulley; when passing over the head and tail pulleys the belt assumes a flat form.

An advantage claimed for this type of conveyor is that the use of costly troughed idler roller sets is obviated, with an additional saving on spares and maintenance. The channel belt, according to speed and loading requirements, can be carried on a flat, wooden deck, a steel plate deck relieved at intervals by standard parallel idler rollers or, for heavy loading, parallel idler rollers.

The carrying capacity of the 12-in.-wide channel belt is stated to exceed that of the 26-in. troughed idler belt for all materials in powder form up to lumps of 2-in. cube. Belt speeds up to 400 ft./min. are permissible.

'Zipper' closed-belt conveyor

Another type of conveyor by Rownsons has advantages where strict control of the materials being carried is necessary. It consists of (1) a flat, endless base belt similar to the conventional rubber and fabric conveyor belt; (2) flexible rubber side walls hinged to the shoulders of the base belt and (3) interlocking rubber teeth moulded on the outer edges of the side walls. The side walls are closed about the load to eliminate spillage, escape of dust and contamination of the material from outside sources.

This conveyor can convey and elevate in any direction and a single belt will operate over several places and over considerable distances. The belt is opened automatically for loading and is then automatically closed up to the point of discharge, where it is re-opened. Movable discharge can be incorporated, allowing a number of hoppers or stations to be accommodated.

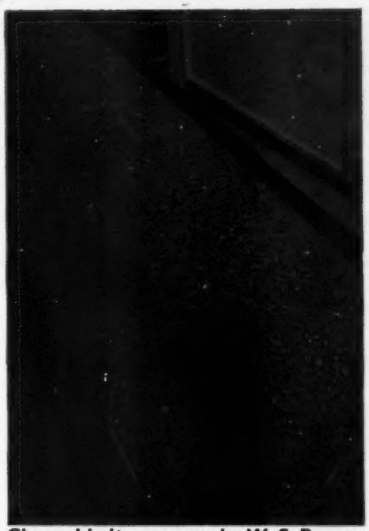
Screw conveyors and lifts

Screw lifts, which are vertical worm elevators, are available for handling

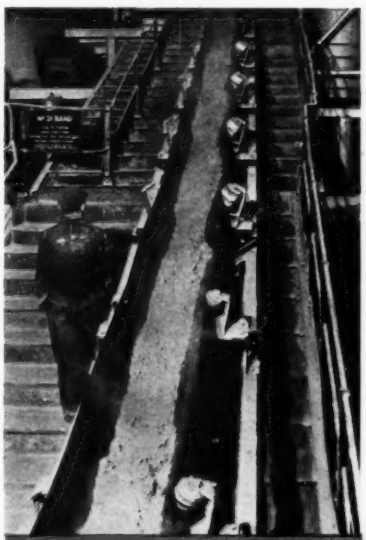
from 100 to 2,500 cu.ft./hr., and can often be used for solving difficult elevating problems. Heart of the unit is a tapered, endless screw which receives the material from the feeder and starts the vertical movement without compression, thus ensuring that there is no damage to the material carried. Each section is readily replaceable or can be added to if extensions are required. The split casing can be easily removed for inspection or when cleaning is necessary.

Equipment of this type, made by W. S. Barron & Son Ltd., was illustrated in CHEMICAL & PROCESS ENGINEERING, 1956, **37** (7), 250. This compact unit requires little space and is easily installed. All top gear boxes may be fitted with mitre gears or 2 : 1 bevel gears. The discharge head and top drive unit may be fitted at any angle. Types B, C, D and F are fed by means of a horizontal conveyor and are suitable for all types of free-flowing bulk materials and soft stocks.

The same makers also offer screw conveyors for conveying bulk material horizontally or at an angle of up to 30°. Outlets can be fitted wherever required along the length of the trough and operation can be manual, by screw lever, or electrically controlled by a pneumatically operated slide.



Channel-belt conveyor by W. S. Barron is seen here handling two types of grain: millet peas (*left*) **and milo** (*right*) **in two separate flows after discharge from vibrating screens.**



Thin, flexible conveyor belts with considerable heat and wear resistance can be made from 'Terylene'. At the I.C.I. chemical fertiliser plant, Billingham, it has been possible to 'deep trough' belts to eliminate spillage at loading points. Labour formerly employed in reclaiming and reprocessing spilled hot material can be more usefully employed. As well as reduced maintenance costs, this means a saving of £800 p.a. for a belt of 37-ft. centres.

Bearings for conveyors

Where there are corrosive conditions, bearings present a problem, and non-metallic materials of construction may be considered. Carbon bearings are available which have high resistance to corrosive chemicals and, being self-lubricating, need no maintenance. They are high-temperature bearing materials and most grades will operate at up to 350°C. in air, whilst the regular grades for higher temperatures can be safely used at 500°C. Even at this temperature there is no loss of the self-lubricating quality, according to the makers, the Morgan Crucible Co. Ltd.

Carbon bearings are used where the elimination of oil or grease is necessary and where conditions and temperatures render conventional bearings unsuitable. Other useful properties include good compressive strength, absence of creep and good resistance to thermal shock.

Carbon bearings have five or more times the strength in compression than in tension, hence they should be mounted in compression, *i.e.* shrink or press fitted. This will also overcome the difference in expansion between the carbon liner and its housing, as the coefficient of thermal expansion of carbon is approximately one-sixth that of austenitic stainless steel.

It is not always possible to replace other types of bearing directly by carbon, but usually only a small amount of design modification is necessary. Rough or rusted shafts are not suitable as they will tend to grind the carbon; uniformly hard surfaces, smoother than 40 micro-in. finish, are recommended.

Mechanical Handling in the Chemical and Allied Industries

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of merchandise and products. The picking up of loads suitably stored on or in pallets or bins of many kinds and other forms of materials containers, transporting them and stacking them where required to the very limit of headroom available, even in a confined space, is one of the principle features of these trucks. This method of conveyance is comparatively new in Britain, but nevertheless there is a very wide range of such trucks available. The four basic types of power units are petrol, diesel, petrol/electric and storage battery, all of which have certain capacities and range from 2,000 to 3,000 lb. and upwards, while the bulk of trucks are in the 4,000 to 6,000 lb. category. Such equipment is capable of effecting substantial saving in labour—for example, on many types of work, with a driver only, the equipment can do the work of eight to ten men.

The fork-lift truck is flexible and does not have to follow a fixed production path. It is also interesting to note that many kinds of other useful production attachments may be suitably fitted to the fork-lift truck and, in this way, other work undertaken. The trucks may be converted into cranes, shovels, drum carriers and various types of lifting devices to quote a few of the additional facilities possible, and new fittings are constantly being planned.

The pallet and the truck are two of the main pieces of equipment making their appearance in the production lines of many plants. Other types of materials handling devices are coming forward and are worthy of investigation by those responsible for the storage and conveyance of raw materials in every phase of manufacture. In addition, there is a wide range of conveyors, lifting gear and other equipment designed to meet the needs of mass production.

Recovering Uranium from Lignites

Extensive investigations into the extraction of uranium from Dakota lignites have been carried out in the U.S.A. This article describes pilot-plant tests which will serve as a guide in evaluating the economics of commercial-scale extraction, and in selecting a flowsheet and designing equipment for a process mill.

EXPLORATION and development work in North and South Dakota has shown that significant deposits of uraniferous lignites exist. Early investigations into the extraction of uranium from some of the first-known deposits of lignites were conducted at the Battelle Memorial Institute[1] and at the Oak Ridge National Laboratory.[2] As prospecting and discovery work progressed, samples from larger deposits of much higher uranium grade became available. A testing programme was initiated at the Raw Materials Development Laboratory, Winchester, Massachusetts, in November 1954. Nearly 50 individual lignite samples were subjected to exhaustive laboratory tests including various methods of roasting, leaching, and uranium recovery in order to develop the most economical process for treating the ore.

At the request of the Raw Materials Division of the U.S. Atomic Energy Commission, investigations on the production of a uranium concentrate from uraniferous lignites were conducted at the Grand Junction pilot plant during the period January to August 1957. These studies included process development work and amenability testing of four lignites: from International Resources, Ohio Oil Co. (Klym Mine), Ohio Oil Co. (Johnson Mine) and Northgate. Approximately 1,750 tons of wet lignite were processed in the course of the test work.

The purposes of the pilot-plant investigation were: (1) to project the proposed flowsheet for *FluoSolids* roasting—two-stage acid leaching—countercurrent decantation and/or filtration—solvent extraction into an operable process, (2) to test the amenability of the various lignites mentioned above to that process, and (3) to obtain design data for possible commercial application. Existing pilot-plant equipment was used wherever possible in completing the flowsheet. Time and quantity of sample limitations did not permit complete investigations of all process variables. A portion of the programme was devoted to applying standard mill equipment to the treatment of lignite in such a manner as to minimise operational difficulties.

Pilot-plant work

The lignites were first roasted in a *FluoSolids* reactor, then leached with sulphuric acid, and finally washed in a thickener, countercurrent decantation and/or filtration circuit. The uranium values were recovered from the acid wash solutions by means of solvent extraction. Best leach extraction was obtained on roasted material that had a low loss-on-ignition assay (dead roast material).

For a dead roast, maximum daily feed rates were 5.8 dry tons of lignite with a heat content of 4,140 B.Th.U./lb.

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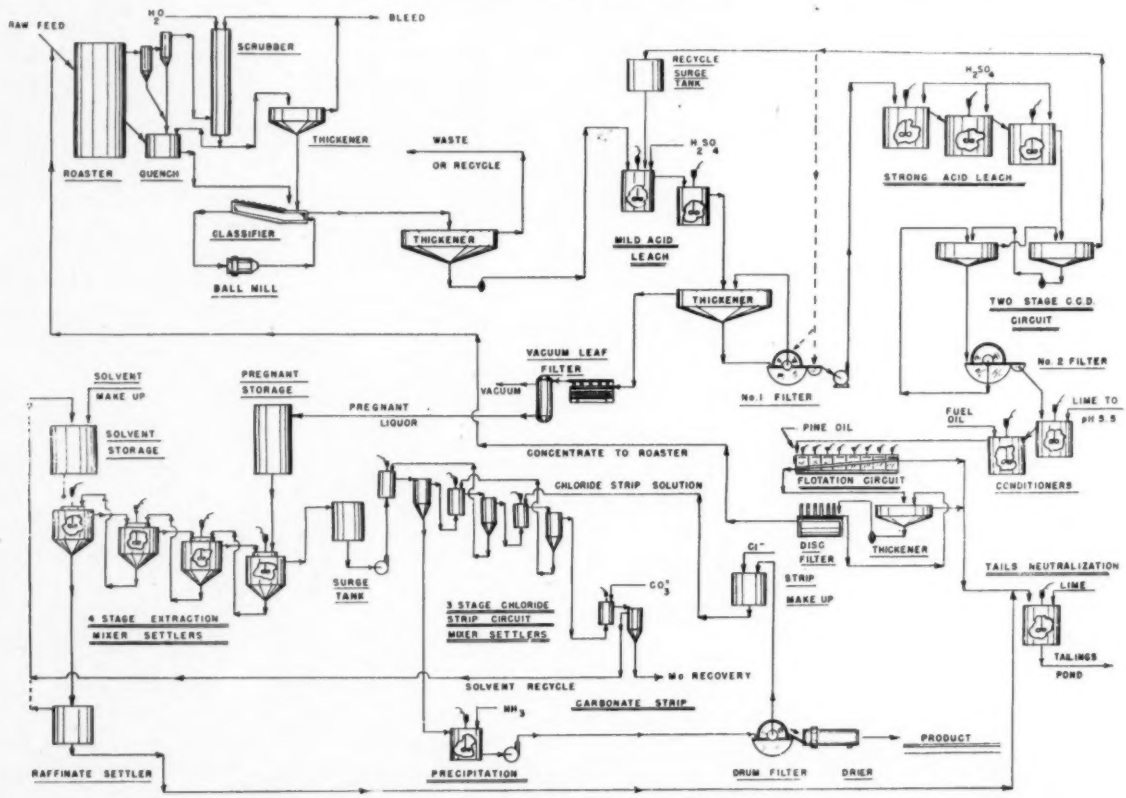


Acid leach—solvent extraction circuit for uraniferous lignite ores[3].

Boiler Feedwater Treatment

By P. Hamer, B.A., A.I.C.

(Imperial Chemical Industries Ltd., Alkali Division)

The author deals principally with feedwater treatment for boilers working at pressures up to 1,000 *p.s.i., since this range covers the majority of industrial boilers in the U.K., but there are some references to conditions needed in higher-pressure boilers. Boiler pressures as high as* 4,500 *p.s.i. have been or are about to be used for power generation, and these very high pressures are presenting some water treatment problems which have not yet been fully worked out.*

THE salts in natural waters have certain well-known effects in boilers, namely scale formation on heating surfaces, corrosion in all parts of the boiler plant, and contamination of the steam with boiler salts and gases, which may cause deposits and corrosion in superheaters, turbines, and on other metal surfaces on which steam condenses. These effects are interlinked by the fact that any treatment applied to the feedwater to eliminate one of them usually affects the others. Furthermore, the water as it passes through the boiler plant to emerge as steam is subjected to three stages of heating and one of cooling, in each of which special effects are produced. For example, in the first stage the water is heated, usually without evaporation, to temperatures of the order of 100 to 150°C., in a feedwater heater or economiser, or both, in which it is passed through tubes heated by steam from the turbine or flue gases from the boiler furnace. Here, temporary hardness due to bicarbonates breaks down into calcium carbonate and basic magnesium carbonate which deposit on the metal, and carbon dioxide gas which, together with the dissolved oxygen, can corrode metal unprotected by deposits.

The water then passes into the boiler drum, where it is heated almost instantaneously to the boiling point, *i.e.* 170°C. at 100 p.s.i. and 286°C. at 1,000 p.s.i. gauge, and is evaporated to the extent that the residual water, called boiler water, contains the salts in the feedwater concentrated about 6 to 200 times. These two conditions lead to the crystallisation on the metal of substances such as calcium sulphate, calcium and magnesium silicates, etc., as hard adherent scales.

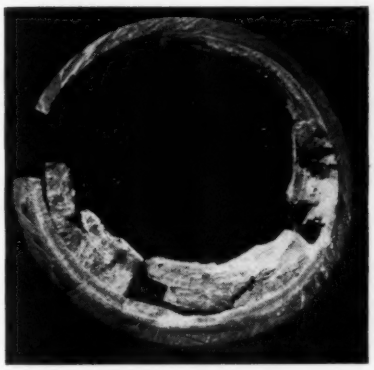
The steam then passes through the superheater in which, for power generation, its temperature may be raised to as high as 450 to 500°C. Carbon dioxide and oxygen present in the steam originating in the feedwater, together with small quantities of boiler water salts carried over by foaming or spraying, can cause corrosion and deposits in the superheaters, and in the turbine as the steam expands and cools. The gases will also make the condensed steam acid, so that when it is returned to the boiler as feedwater it can carry with it iron oxides and copper salts derived from the corrosion of pipelines, tanks and pumps.

The treatment of boiler feedwater must therefore be considered as a whole, in the light of the possible effects at all points of the boiler plant and beyond to the turbines or space-heating system, or wherever the steam is used. The aim of the treatment is to control the chemical reactions taking place between the salts in the water and between water and metal, the treatment chemicals and methods of application being chosen to suit the composition of the water and the operating conditions of the boiler.

It is now proposed to discuss the principal methods of treatment to prevent scale, corrosion and impurities in steam.

Prevention of scale

The scales formed in economisers and boilers have a low thermal conductivity estimated at between 8 and 24 B.Th.U./sq.ft./hr.°F., so that the metal under them is not properly cooled and in the hotter parts of the boiler its temperature rises to the softening point, after which the tube bulges and splits. In furnace wall and other tubes exposed to radiant heat, when rates of heat transfer and evaporation are high, hard scales no thicker than 0.1 in. can cause failure. The direct loss of heat or waste of fuel caused by scales has been estimated at about 2% or less in water tube boilers, but may be up to 5% or 6% in smoke tube boilers where heating surfaces are short. The major losses are the cost of replacing burst or bulged tubes, the interruptions in plant operation and the fuel needed to start up a spare boiler.[1]



Hard calcium sulphate scale formation in a water tube boiler. The gaps and cracks in the scale are due to pieces being removed for examination and then replaced.

The chief constituents of the deposits are calcium and magnesium compounds, so that the logical first step is to remove calcium and magnesium in a softening plant or, if the hardness is not too high, by precipitating them in the boiler itself. The choice of softening process needs some care and depends on the composition and temperature of the raw water, the boiler pressure, and the use to which the steam is put. The modern tendency is to use the purest water at the highest boiler pressure, though it is not clear that this is essential. It is not possible to go into the details affecting this choice here; it suffices to say that, although each process removes calcium and magnesium, the amounts of other salts present are altered to a varying degree. Broadly speaking, the best choice is the process which results in a substantial reduction in dissolved salts and silica, and the least amount of CO_2 in the steam.[2]

Boiler feedwater conditioning. There is always some residual hardness in a softened water and this, together with small amounts of hardness due to contamination of returned condensate or by leakage of turbine condenser cooling water, can cause scale. Small amounts of chemicals are therefore added to counteract scale formation and to adjust the composition of the feed and boiler water to prevent corrosion. The process of adjustment is generally known as ' conditioning.'

To prevent scale at boiler pressures below about 200 p.s.i. sodium carbonate is used, since it precipitates calcium as carbonate and is also partly decomposed at these temperatures to NaOH, which precipitates magnesium as hydroxide. These substances, being of very low solubility, form soft sludges which can be removed from the boiler in the blowdown.

At higher boiler pressures the extent of the decomposition may make it difficult to maintain the required concentration of carbonate in the boiler water, and sodium phosphate is used since the PO_4 ion is stable at all boiler temperatures and calcium phosphate also forms a soft sludge. Magnesium is precipitated as hydroxide and, if there is not enough OH ion in the softened water for this purpose, Na_2CO_3 or NaOH must be added. Phosphate should be added in amounts to exceed the calcium hardness and maintain an excess of 75 to 150 p.p.m. Na_3PO_4 in the boiler water as a temporary reserve against unexpected variation or intrusion of hardness.

Softening in the boiler. The practice of adding chemicals direct to the boiler to soften and condition the feedwater inside the boiler has long been known. It avoids the cost of a softening plant, but owing to the amount of sludge formed it has usually been limited to waters of moderate hardness (up to 150 p.p.m. $CaCO_3$) and boilers working at pressures up to about 300 p.s.i.

The general procedure is, first, to add a small amount of *Calgon*, or a mixture of *Calgon* and tannin, contiously to the raw water feed, to delay the precipitation of Ca and Mg in the economiser; then to add precipitating chemicals, sodium carbonate or phosphate or both, sometimes mixed with tannin and antifoam, direct to the boiler. Thus the temporary hardness is precipitated by the heat and the permanent hardness by the chemicals.

When this treatment is properly carried out the hardness is precipitated as a sludge which should be removed by the bottom blowdown cock in the boiler, and this control of the amount of sludge is important.

A difficulty with this treatment in the past has been the control of the mobility of the sludge, and many cases are known in which part of the sludge has stuck to the boiler heating surfaces and the rest has compacted in the bottom of the boiler and has been difficult to remove.

A study which has recently been published[3] has shown a relationship between the mobility and composition of the sludge obtained by carbonate treatment, and by means of which the sludge can be made free-flowing and the heating surfaces kept clean. This relationship does not hold when phosphate is the precipitating chemical, but with carbonate treatment there are two conditions to be fulfilled:

(*a*) The magnesium hardness of the feedwater must be kept above a certain minimum level, which is related only to the calcium hardness and silica content and is expressed in the formula

$$X = \frac{100}{CaH}\left(\frac{MgH}{3} - SiO_2\right)$$

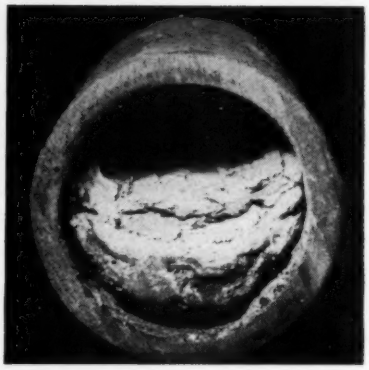
where Ca*H* and Mg*H* represent Ca and Mg hardness in p.p.m. $CaCO_3$, and SiO_2 is the silica content in p.p.m. X is a dimensionless quantity which should be kept above 7.0. The usual way of adjusting this is to add a magnesium salt.

(*b*) The total carbonate alkalinity in the boiler water should be between 200 and 300 p.p.m. $CaCO_3$ with 300 the preferred figure.

The process has been applied to many boiler plants working at medium pressures with a great improvement in cleanliness, but, as it is still regarded as a new development, it is strongly recommended that expert advice should be sought before applying it.

Prevention of corrosion in boilers

Boiler steel and water react at boiler temperatures liberating hydrogen, and forming magnetite as an adherent layer on the metal which protects it from further attack. A break in this layer produced by chemical action, or thermal or mechanical shock, will expose the underlying steel to further attack. The subsequent events will be determined by the chemical and physical conditions at the break, because if these favour the formation of fresh nuclei of magnetite close to the break the magnetite layer will be self-healing, whereas if they form a short distance away corrosion may persist and the hydrogen evolved may embrittle the metal.[4]



Corrosion occurring underneath deposits in a high-pressure boiler, 900 p.s.i.

It is known that alkalis such as sodium phosphate and caustic soda reduce corrosion, though high concentrations of the latter may dissolve the magnetite, and dissolved oxygen promotes it, so that the best way of reducing corrosion in boiler plants to a minimum is to maintain an alkalinity in the feed and boiler water and to remove dissolved oxygen from the feedwater.

At boiler pressures below about 200 p.s.i. experience shows that adequate protection is secured if the alkalinity of the boiler water is kept at about 15 to 20% of the total salts, and the *p*H of the feedwater is not less than 9.

Above 200 p.s.i. the safest course is to reduce the oxygen content of the feed to at least 0.05 p.p.m. and at 1,000 p.s.i. and above to less than 0.01 p.p.m. by deaeration under vacuum or at high temperatures, and as an extra safeguard it is customary to supplement this by the addition of reducing agents such as sodium sulphite or hydrazine to remove last traces of oxygen and to deal with unexpected contaminations. The proportion of anhydrous sodium sulphate (100%) to oxygen needed is 8 : 1 by weight and it is usual to add excess to maintain a concentration of 30 to 50 p.p.m. Na_2SO_3 in boilers at pressures up to 1,000 p.s.i. and 10 p.p.m. or less at higher pressures. Catalyst mixtures containing cobalt salts are now available to hasten the reaction with oxygen. The proportion of pure hydrazine needed is 1 : 1 (commercial hydrate about 3 : 1). An excess of about 150% is required to expedite the reaction and the concentration in the boiler water recommended is about 0.05 p.p.m. Hydrazine is probably more suitable for pure feedwaters and high-pressure boilers.[5]

Corrosion in the absence of oxygen. In practice it has been found that corrosion sometimes occurs when the oxygen content of the boiler water is very low or even absent, and it is believed that this attack is largely due to the action of concentrated boiler salts trapped within piles of loose deposits of, say, calcium phosphate, or iron oxide lying in boiler tubes. The remedy is, of course, to improve water treatment to reduce the amounts of calcium phosphate and iron oxide entering the boiler and to improve water circulation. Other cases are reported to have occurred in clean tubes subjected to high heat input, and it seems wise to design the boiler with too much rather than too little heating surface and to avoid local hot spots.[6]

Caustic cracking. This type of corrosion has been described many times and, despite a great deal of research, the mechanism is not fully understood, nor is it possible to guarantee that the standard remedies will be invariably successful. The riveted seam in the boiler drum is the point of weakness, and when boiler drums are welded and stress-relieved the trouble is avoided. On the water side the usual recommended safeguard is to maintain the ratio $Na_2SO_4/NaOH$ in the boiler water above 2.5. Sodium nitrate has also been recommended as an inhibitor, but not for boiler pressures above about 600 p.s.i. The amount used should provide a ratio $NaNO_3$/total alkalinity in the boiler water expressed as NaOH, greater than 0.4. In some waters the natural sulphate or nitrate contents are enough to fulfil these conditions. The most certain method of protection is to destroy all NaOH in the boiler water by the addition of *Calgon* or other acid phosphates, so that the alkalinity of the boiler water is entirely due to sodium phosphates, but this treatment may be expensive if the NaOH in the boiler water is high, and it requires a little more chemical supervision than the addition of nitrate or sulphate.[7]

Corrosion in idle boilers. When boilers are drained and allowed to stand there is bound to be some corrosion of the wet metal surfaces, especially underneath soft deposits or loosened scale. Although this attack is usually superficial it is believed that by repetition it can sometimes become more deep-seated and localised, persisting during running and leading to perforation. For long periods of standing it is therefore recommended that, after hosing down to remove sludge and detach any partially loosened scale, the boiler should be thoroughly dried out with hot air and then closed up with trays of quicklime in the drums to keep the atmosphere dry. For short periods the boiler can be filled up to the top with alkaline feedwater dosed with sodium sulphite or hydrazine 200 to 300 p.p.m. The solution strength should be checked once per week and when the boiler is required the level can be lowered below normal working and the boiler blown down fairly freely for a day or two to get rid of excess chemical.

Prevention of corrosion and deposits from steam

Corrosion. Corrosion in space-heating systems, closed boiler feed systems and other places where steam condenses can be severe and is due to carbon dioxide and oxygen in the steam. The preliminary countermeasures are to remove oxygen down to about 0.05 p.p.m. and to reduce the carbonates in the boiler water and bicarbonates in the feed, which are the sources of CO_2. Should the amount of CO_2 in the steam be small but still enough to cause some corrosion, this can be countered by adding volatile alkalis in the form of ammonia, cyclohexylamine, or morpholine, to the boiler water to neutralise the CO_2 and raise the *p*H value of the condensate to 9.[8] Alternatively the problem may be solved by spraying into the steam an aqueous emulsion of a long-chain amine, such as stearylamine, which is carried by the steam and forms a protective film on the metal surfaces. This is known as a filming amine treatment and both methods have been used successfully in the United States and are now being used here.[9]

Table 1. Critical Concentrations of Dissolved Solids in Boilers

Boiler pressure (p.s.i.)	*Maximum dissolved salts in boiler water (p.p.m.)*
0– 200	15,000 (economic boilers 4,500)
200– 300	15,000 – 5,000 (may be 3,000 in highly rated boilers)
300– 600	5,000–2,500
600– 900	2,500–1,500
900–1,500	1,500– 500

Table 2. Maximum SiO_2 p.p.m. in Boiler Water to Give 0.02 p.p.m. SiO_2 in Steam

	Boiler pressure, p.s.i. gauge						
	500	1,000	1,200	1,400	1,600	1,800	2,000
Boiler water *p*H 10	11	6	4	2.5	2	1	0.8
11	19	11	7	5	3	2	1
12	33	20	13	8	6	4	3

Deposits. Solids are introduced into steam either by entrainment of boiler water or dissolution of silica in saturated and superheated steam at high pressures. The entrainment, or 'carryover,' of boiler water salts can be promoted by various circumstances operating together or independently—for example, high water levels, sudden changes in steam load, leakage past baffles in the steam/water drum, and the high concentration of dissolved salts and suspended solids in the boiler water. It seems to be established that for a given set of steady boiler operating conditions 'carryover' increases rapidly when the concentration of dissolved salts exceeds certain figures, and Table 1 gives a rough indication of these critical concentrations in boilers on steady load and at or below the boilermaker's recommended maximum continuous rating.

Antifoams. The usual practice is to control the concentration of salts in the boiler water at or below the above figures by adjusting the boiler blowdown. There are now available, however, various antifoams which, when added continuously to boiler feedwater, prevent foaming and carryover at much higher concentrations of salts than those shown in Table 1 and so can effect savings in blowdown. For example, in trials on locomotives, concentrations of 12,000 to 20,000 p.p.m. and above could be maintained where in the absence of antifoam serious carryover occurred at 3,000 p.p.m. To establish the cause of 'carryover' often needs skilled investigation and it is therefore recommended that expert advice should be sought before adding antifoams.

Silica in steam. During and immediately after the war a number of cases of very hard deposits of pure silica on turbine blades were reported from America.[10] They occurred in the low-pressure end of condensing turbines at temperatures below about 500°F. and had to be removed by sandblasting or dissolving in hot concentrated NaOH. Subsequent experimental work in Germany and U.S.A.

showed that at boiler pressures above about 1,000 p.s.i. silica in boiler water dissolves in the saturated steam, and redeposits as the steam becomes supersaturated with SiO_2 due to expansion and cooling in the turbine. It now seems agreed that there is danger of these deposits if the SiO_2 content of the steam leaving the boiler is greater than 0.02 p.p.m., and the figures in Table 2 taken from recent American work[11] show the maximum SiO_2 in boiler water needed to give 0.02 p.p.m. SiO_2 in steam. To avoid these deposits SiO_2 may have to be removed from the feedwater, or its concentration in the boiler water controlled by blowdown. The figures in Tables 1 and 2 should therefore be used together for the control of boiler blowdown.

Conclusion

In this article an attempt has been made to present an overall picture of the principles and methods of boiler feedwater treatment with some indication of the practical steps needed to carry them out. To summarise:

(1) *Softening process* should be chosen to yield:

(*a*) Low total dissolved solids—to reduce boiler blowdown.

(*b*) Low hardness—to avoid sludge in the boiler.

(*c*) Low bicarbonate (HCO_3), when corrosion by condensed steam is to be expected.

(*d*) Low alumina and silica where necessary (principally boilers at above 1,000 p.s.i.).

Or (2) softening in the boiler for shell-type and intermediate pressure water-tube boilers which are not working at high steaming rates. Control of sludge mobility by adjustment of feedwater composition.

(3) *Conditioning treatment:*

(*a*) Addition of sodium carbonate to prevent scaling in boilers working at pressures below 200 p.s.i. Hardness of filtered boiler water tested by Wanklyn foam test should be nil (or less than 8 p.p.m. by E.D.T.A. test). Some methods of water softening leave enough sodium carbonate in the treated water.

(*b*) Addition of phosphates — for scale prevention in boilers at pressures above 200 p.s.i., or in low-pressure boilers if the silica content of the feedwater is above about 10 p.p.m. Na_3PO_4 and in boiler water 75 to 100 p.p.m.

(*c*) To prevent corrosion in feed lines and boilers working at pressures up to 200 p.s.i. the feedwater should be alkaline to phenolphthalein and the total alkalinity of the boiler water should be 15 to 20% of its total dissolved solids content. This alkali is present in some softened waters.

(*d*) To prevent corrosion above 200 p.s.i. the feedwater should have a *p*H value 9 and the boiler water a caustic alkalinity of about 10% of the T.D.S. content. The feedwater must be deaerated to reduce oxygen to less than 0.01 p.p.m. and it is often advisable to supplement this with chemical deaeration using sodium sulphite or hydrazine.

(*e*) Addition of sodium sulphate, sodium nitrate or acid phosphate to guard against caustic embrittlement in boilers fitted with riveted drums.

(4) Controlled continuous blowdown to maintain the T.D.S. and SiO_2 content of the boiler water in the ranges suggested (Tables 1 and 2). Intermittent blowdown to control the amount of sludge in the boiler.

(5) Special addition of sodium sulphite or hydrazine to protect idle boilers against corrosion.

(6) The institution of a schedule of regular sampling and testing to observe and control the treatment at all stages.[12]

The author would like to thank the directors of the Alkali Division of Imperial Chemical Industries Ltd. for permission to publish this paper.

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[12] Methods of Sampling Water Used in Industry,' B.S. 1328: 1956. 'Tests for Water Used in Steam Generators,' B.S. 1427: 1949. 'Treatment of Water for Land Boilers,' B.S. 2486: 1954. 'Methods of Sampling and Testing Boiler Water Deposits,' B.S. 2455: 1954. 'Methods of Testing Water Used in Industry,' B.S. 2690: 1956.

British Standards

Welding symbols are available in a wall chart, B.S. 499C: 1958, price 6s. net mounted and varnished, 3s. unmounted and unvarnished. This collection of standard welding symbols is boldly presented in black and white, and the chart measures 23½ in. × 19 in. The symbols, reproduced from B.S. 499, denote the type, size and position of welds in welded joints, and are accompanied by illustrations of their use.

Oils and fats analysis (B.S. 684: 1958, 15s., 'Methods of analysis of oils and fats'). In addition to containing revised texts for the methods specified in the 1950 edition, this publication has also been expanded to cover a number of further methods of analysis. These include: the determinations of melting point; cloud and pour points, flow and drop points of fats; titre, smoke and flash points; drying time; viscosity; Harris iodine value; copper and polybromide value; as well as tests for various individual oils. The methods of the oils and fats division of the I.U.P.A.C., which supersede those of the (then) International Commission for the Study of Fats, have been published separately and so do not appear in the new standard.

Smoke control (B.S. 2978, Part 1: 1958, 5s., 'Measurement of smoke emission from industrial boilers'). This is the first report of the B.S.I. committee which has been investigating the extent to which smoke from industrial boilers can be reduced by good practice, and covers medium-capacity coal-fired water-tube boilers with travelling grates. The next part to be issued will be concerned with shell boilers fired by various kinds of mechanical stokers. To obtain the material on which the report is based, the committee carried out tests on four water-tube boilers of modern design at a brewery, a paper mill, a chemical works and a colliery, keeping detailed records of smoke emission from each over periods of from 5 to 9 weeks.

Copies of these standards can be obtained from the British Standards Institution, 2 Park Street, London, W.1.

Manufacture of Photographic Film Base

A £2½-million factory at Brantham, Suffolk, is claimed to be the only one manufacturing film base in the British Commonwealth. Interesting features of this factory include the extensive use of stainless steel and 'Pyrex' tubing, the use of a silk filtering medium, and the special operating and maintenance techniques made necessary by the tricky nature of the materials handled.

THE manufacture of photographic film base is one of the youngest of British industries, for until 1946 all the base used in the United Kingdom was imported, chiefly from America. The post-war dollar gap made it impracticable for British manufacturers of photographic film to continue these imports on so large a scale and Ilford Ltd., Britain's largest photographic manufacturers, held consultations with a plastics firm—BX Plastics—as a result of which Bexford Ltd. was founded as an associated company. A film base plant was set up and it is from this that the present extensive factory has grown.

Previously, most photographic material was made from nitro cellulose, the exception being *x*-ray base which was made either from secondary cellulose acetate or from acetate butyrate. While the plant was being built, the use of cellulose triacetate for all those types of photographic base which were formerly made from nitro cellulose was being developed in America, and Bexford thereupon adapted its plant designs for the rather difficult procedures involved in making satisfactory triacetate base.

Cellulose triacetate has a much more symmetrical molecule than secondary cellulose acetate and, therefore, is more liable to crystallisation, which leads to brittleness, and it is this factor which leads to the necessity for special techniques in casting. It also requires the use of methylene chloride, a relatively expensive and extremely volatile solvent, and as a result very high solvent recoveries have to be achieved in order to make its manufacture an economic success.

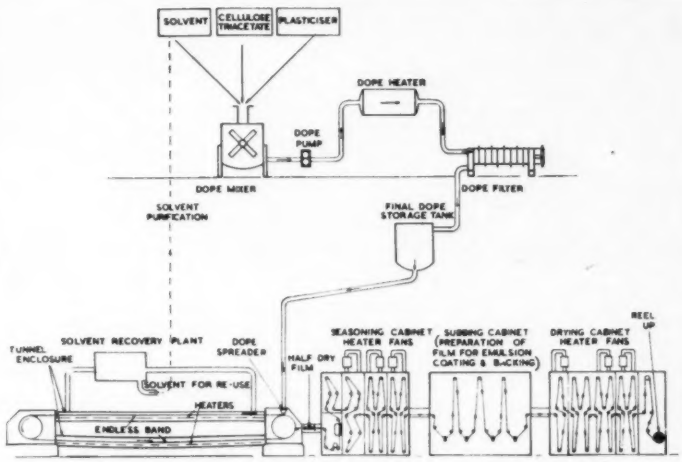
The process

The first stage in the manufacture of photographic film base is the preparation of the 'dope.' This is a mixture of:

(1) cellulose triacetate 'flake' (a coarse white powder made by the interaction of cellulose in the form of cotton linters with acetic anhydride and acetic acid);
(2) a solvent; and
(3) a plasticiser — a non-volatile softening material, such as triphenyl phosphate, which serves amongst other things to make the whole more flexible.

This dope is loaded into a stainless-steel mixer, and is then pumped through a heater which drives off the dissolved air. After being driven under pressure through thick layers of filtering medium, which removes extraneous dirt and haze, the dope passes to a stainless-steel storage tank. From there it goes to a special pumping assembly and so on to a spreader from which it is extruded in a thin layer on to the specially prepared surface of an endless copper band running on steel drums. The whole operation is completely enclosed in an electrically heated casting enclosure. Here the original solvent is driven off into a recovery plant, and the liquid dope becomes a solid film layer which is stripped from the band by means of a stripping roller; thence it passes through a seal, which is the only opening in the enclosure, to a seasoning cabinet. In the cabinet the film passes over a multiplicity of rollers in a highly insulated structure heated by external hot-air heaters running at controlled temperatures.

Next is the 'subbing' (substratum) cabinet, made largely of glass, where extremely thin coatings are applied (*a*) to provide cohesion for the light-sensitive emulsion (not applied at Bexford) and (*b*) in certain cases to the reverse side to control the curl of the film. These coatings are applied



Diagrammatic representation of film-casting process.

View of film-casting machine.

Solvent recovery and distillation plants at Brantham.

in a solution of organic solvents and, in consequence, the film requires further drying. This is done in a cabinet similar to the one used before the subbing operation.

The film is finally rolled in lengths (never less than 1,000 ft.) appropriate to the type of film for which the base will be used.

Solvent recovery

The solvents used in these processes are very expensive and have to be recovered as efficiently as possible. In the case of the casting machine (where the dope is spread) the solvent is sucked through a refrigerator plant, the partially stripped air being purified and afterwards returned to the plant for re-use. Since it is essential that none of these solvents shall escape into the air, the casting cabinet is maintained under very slight suction by means of fans which deliver air, containing a small amount of residual solvent, to large carbon adsorber plants in which they are recovered, purified and subsequently re-used. The solvents used in the subbing cabinet receive similar treatment.

Control and maintenance

The plant is fully automated throughout, and the operations of a whole floor of equipment are observed from a single control panel. There is, however, also a team of maintenance workers. Because of the danger of contamination from the atmosphere, it is impracticable to remove to the outside equipment in need of repair; it is repaired on the floor of the plant, with the workers warded off by a transparent plastic wall. The enclosure is entered by a separate system of doors, controlled by air locks.

Attached to the plant is a laboratory, whose function is to perform tests on raw materials, both incoming and in circuit, and on the finished product. It also conducts research into new and existing methods of film production; at present it is experimenting with the use of polymers to replace cellulose triacetate.

In the testing section, the film is tested for tensile strength, extent of expansion in water, aptitude to tear and to scratch.

Equipment suppliers

Amongst firms who supplied equipment for the Brantham factory were: S. H. Johnson & Co. Ltd. (filter presses); British Carbo Union (carbon recovery plant); British Ceca Co. Ltd. (carbon recovery and distillation plant); Henry Balfour & Co. Ltd., A.P.V. and W. J. Fraser Ltd. (distillation plant); G. A. Harvey, Andrews Bros. (Bristol) Ltd. and Welding Technical Services (mixers and tanks); and Girdlestone Pumps, Varley-F.M.C. Ltd. (pumps).

RECENT PUBLICATIONS

Electrical flow meters. A variety of differential pressure producers, for different measurements, as well as information on open-channel meters employed in weirs and venturi flumes, the electrical transducer flow meter, new miniature indicators, integrators and recorders, and notes upon the installation of differential pressure producers are given in a 26-page catalogue (No. 65) available from Electroflo Meters Co. Ltd., Abbey Road, Park Royal, London, N.W.10, or from The Technical Division, C. P. Wakefield Ltd., 152 Fleet Street, E.C.4.

Instrument selection. New literature, produced by Taylor Controls Ltd., 75 Hale End Road, Walthamstow, London, E.17, includes the revised edition of a bulletin, 98170/GB, which now incorporates the latest *Transcope* recorder and *Transet* potentiometer transmitter, while bulletin No. 9862/GB covers the potentiometer transmitter, a unique concept in a bridge-balancing potentiometer, eliminating the need for a slidewire, battery, standard cell, or moving parts. Bulletin No. 98278/GB covers the *Transcope* controller, and the 90J *Transcope* recorder is covered by illustrated leaflet No. 98282/GB.

Micronic filters. Typical examples of *PurOlator* bulk capacity micronic filters and filter separators are given in an illustrated brochure (No. P671) by Automotive Products Co. Ltd., Brock House, Langham Street, London, W.1.

Flow indicators. Walker, Crosweller & Co. Ltd., Cheltenham, have just issued a new pamphlet illustrating their *Arkon* flow indicators, used to show the flow of cooling water, lubricating oil, cooling oil, gas or air, etc.

Centrifugal separators. A bulletin (No. 2173) describes the uses of the Westfalia separator for clarification, separation and concentration. A copy may be obtained from T. Giusti & Son Ltd., Bell Isle Works, 210-212 York Way, Kings Cross, London, N.7.

Dielectric fluids, *Aroclors* and *Pyroclor*, and their use in capacitors and transformers, are the subject of a new 50-page booklet from Monsanto Chemicals Ltd., Monsanto House, Victoria Street, London, S.W.1.

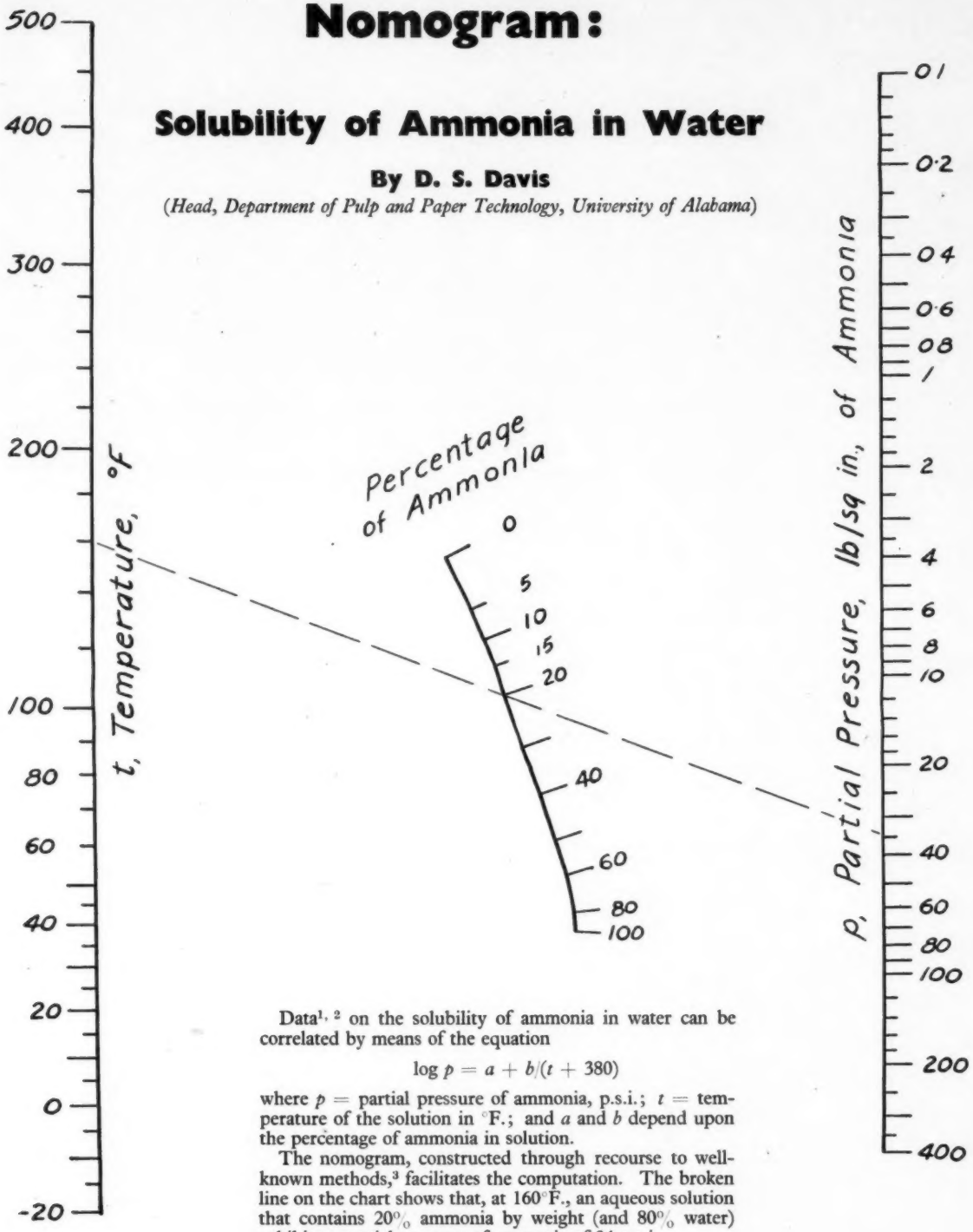
Instrumentation. From Sunvic Controls Ltd., 10 Essex Street, London, W.C.2, comes a folder on instrumentation, illustrated with photographs and describing the various instruments and services supplied by this company. Other leaflets include liquid level controls and transmitters, recording control stations, valve positioners, and multi-function and pneumatic multiplying relays.

Nomogram:

Solubility of Ammonia in Water

By D. S. Davis

(Head, Department of Pulp and Paper Technology, University of Alabama)



Data[1, 2] on the solubility of ammonia in water can be correlated by means of the equation

$$\log p = a + b/(t + 380)$$

where p = partial pressure of ammonia, p.s.i.; t = temperature of the solution in °F.; and a and b depend upon the percentage of ammonia in solution.

The nomogram, constructed through recourse to well-known methods,[3] facilitates the computation. The broken line on the chart shows that, at 160°F., an aqueous solution that contains 20% ammonia by weight (and 80% water) exhibits a partial pressure of ammonia of 34 p.s.i.

REFERENCES

[1]W. C. Bulkley and R. H. Swartz, *Refrig. Engg.*, 1951, **59,** 660.
[2]G. Scatchard, *Ibid.*, 1947, **53,** 413.
[3]D. S. Davis, ' Nomography and Empirical Equations,' Chap. 10. Reinhold Publishing Corporation, New York, 1955.

New Books

Plastics for Engineers

The trouble with books on plastics generally is that, with the constant advances being made in developing new materials, new production and fabrication techniques, they tend to become quickly out of date. However, it is a consolation that conservatism where new materials and techniques are concerned makes engineering applications lag somewhat behind the newer advances. In the American work at present under review* a good deal of the discussion is devoted to the composition and fundamental properties of plastics, the idea behind this being commendable, although in practice it is somewhat confusing in a book of reference to find a lengthy discussion of the properties of polythene, for instance, followed without a break and without any sub-heading by details of fabrication methods. However, some sacrifice obviously had to be made in a volume of this size which seeks to simplify the whole subject of plastics for those who work with such materials or who need background information for their proper use or specification.

The main types of plastics are dealt with in separate chapters and the author wisely deals with the simpler materials first. Chapters on silicones and rubber follow, and the remaining third of the book is devoted to moulding methods, and to engineering, thermal and electrical properties with, finally, an explanation of plastics chemistry and tables giving chemical formulae, general characteristics and typical applications for representative plastics. The absence of any bibliographies or references to more detailed works is to be regretted, but otherwise the book serves as a useful guide.

**Engineering Properties and Applications of Plastics*, by G. F. Kinney. Chapman & Hall, London, 1957. Pp. 278 inc. index, illus., 54s. net.

Scaling Up

Conferences are unquestionably a useful means of advancing knowledge of a technical subject; owing to the rapidity with which conferences are usually conducted, and the wealth of ideas presented, a summary of the conference in printed form is perhaps even more useful to anyone but the direct participants, and especially to those who wish to study some aspect of the subject in a more leisurely way than is possible in the conference hall. Technical journals provide reports on meetings and symposia which pick out the salient points, but there is sometimes a demand for the complete proceedings. In this category comes the Institution of Chemical Engineers' recently published volume* on the 'Joint Symposium on the Scaling-up of Chemical Plant and Processes,' held in London on May 28 and 29, 1957, in conjunction with Het Koninklijk Instituut van Ingenieurs, De Koninklijke Nederlandse Chemische Vereniging and the Society of Chemical Industry.

The 13 papers are reprinted in full and some 34 pages are devoted to the discussions which ended the four sessions of the symposium. The book is a useful record of a memorable and well-attended gathering.

**Proceedings of the Joint Symposium on the Scaling-up of Chemical Plant and Processes.* Institution of Chemical Engineers, London, 1958. Pp. 136, illus., £3 (£2 to members of sponsoring bodies).

Physical Chemistry of Electrolytic Solutions

This new edition* of a work which has been drastically revised is an extremely useful handbook for everyone concerned with fundamental research involving solutions of electrolytes. The thermodynamic treatment has been extended by the addition of a section on irreversible thermodynamics. The statistical theory of simultaneous steady-state processes is developed. The principles of irreversible thermodynamics are used to derive the equations for liquid junction potentials, Soret effect and the equilibrium centrifuge.

Many new sections make their first appearance in book form. Among them are Mayer's cluster-sum theory of thermodynamic properties; conductance theory with inhomogeneous terms and ion size parameters; new solution of conductance equations applicable to any number of ions; and general theory of the Wien effect. Applications of these theories occur throughout the work. There are also extended treatments of the diffusion of electrolytes and self-diffusion of ions, and of the thermodynamics of two electrolytes in water.

The two appendices of the second edition have been consolidated, and much new material added, some tables being revised or completely recalculated. An extensive bibliography is included, with detailed author, subject and chemical indices.

**The Physical Chemistry of Electrolytic Solutions*, by H. S. Harned and B. B. Owen. Third edition. Chapman & Hall, London, 1958. Pp. 803 inc. indices, illus., £8.

Phenolic Resins

The appearance of this volume* dealing with the chemistry of the phenol-formaldehyde reaction will be welcomed by those who have found a lack of detail in previous works on this subject. The summary of most of the important papers that this book provides will be useful to workers who are just entering this field or who have an interest in its complexities.

A general brief summary of developments up to 1939 is given, but it is on the period after this that the author concentrates, when the revolutionary findings on the behaviour of phenolic alcohols were first reported. The author has further restricted himself to formaldehyde, and claims to have omitted few important papers on the subject.

Future lines of work which remain to be examined are indicated, and the emphasis is almost entirely on pure chemical investigations, technological aspects having been virtually ignored. There are chapters on the heating of phenolic alcohols; special reactions of phenols, phenolic alcohols and related compounds; rational syntheses; rates of reaction and kinetic studies; fine structure of resins; and general investigations. The book is clearly indexed, and contains many tables and diagrams.

**Phenolic Resin Chemistry*, by N. J. L. Megson. Butterworths Scientific Publications, London, 1958. Pp. 323 inc. index, illus., 65s.

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Technology Notebook

Research — Education — Discussion

Higher awards for D.S.I.R. students

The value of awards for D.S.I.R. students receiving postgraduate training in science and technology is to be increased by 10% as from October 1. The increases will apply to both research studentships and advanced course studentships.

Some 2,000 postgraduate students will benefit, the value of research fellowships being increased at the same time.

Extending the knowledge of lead

A number of ' open days ' marked the inauguration of the new offices of the Lead Development Association in Adam Street, London, W.C.2. The Association is an advisory, non-profit-earning body, the principal objects of which are to extend the knowledge of lead and its uses and to foster appreciation of its merits. Metallurgists, competent to advise and assist in problems relating to the metal and its applications, supplement the established services of the technical information bureau.

Engineering training in India

The Indian Institute of Technology, second in the chain of four higher technological institutes to be set up by the Central Government, was recently opened in Bombay. It will admit 100 students to various engineering courses to start with, and is being planned to provide facilities for training 1,500 under-graduates and 500 post-graduates.

The Institute is being set up with the assistance of the U.S.S.R. under Unesco's expanded technical assistance programme and, for the present, besides organising several refresher courses, it will provide training facilities in chemical, civil, electrical, mechanical and metallurgical engineering only.

New member for B.N.E.C.

The recent feat of the American nuclear-power submarine *Nautilus* gives added interest to the announcement from the British Nuclear Energy Conference that it has increased its membership to nine constituent bodies by the addition of the Joint Panel on Nuclear Marine Propulsion.

The B.N.E.C., formed in 1955 to provide a common forum for engineers and scientists engaged in the application and uses of nuclear energy, is represented by Sir Willis Jackson at the second Geneva conference on the ' Peaceful Uses of Atomic Energy.'

Non-destructive testing

A summer school on the principles and practice of non-destructive testing, intended to benefit senior and chief inspectors from industry, is to be held in Manchester from September 8 to 12. It has been sponsored by the British National Committee for Non-Destructive Testing and is being organised by the Manchester College of Science and Technology, the Manchester Association of Engineers, and the Institution of Engineering Inspection.

Recovering Uranium From Lignites

(*Concluded from page* 318)

and 5.3 dry tons of lignite containing 5,460 B.Th.U./lb. This is equivalent to 0.82 and 0.75 ton of dry lignite per sq. ft. of roaster cross-sectional area per day, respectively.

The tests showed that, when using 350 to 378 lb. H_2SO_4 per ton of dry raw lignite, 84.5 to 91% of the uranium was leached from an ash produced in the *FluoSolids* roaster. Leaching was accomplished in a two-stage leach circuit at elevated temperatures.

Utilisation of a thickener between leach stages and two thickeners followed by one stage of filtration resulted in a soluble loss of less than 1% through the addition of approximately 4 tons of wash water per ton of ash fed to the circuit. Thickener unit area requirements in the washing circuit range from 8 to 9 sq.ft./ton ash/day for the first washing thickeners to approximately 4 sq.ft./ton/day for the final thickener. Filtration rates in the range of 1,154 to 1,666 lb./sq.ft./day were obtained in the final stage of washing.

Solvent extraction

The uranium values were recovered from the clarified leach liquor in a solvent extraction circuit by using a 0.1*N* solution of an unsaturated secondary amine in kerosene. Five stages of extraction and three stages of stripping were utilised to recover over 99% of the uranium in the leach liquor. Approximately 2.5 lb. of NaCl and 0.1 lb. H_2SO_4 per lb. of U_3O_8 were required to strip the uranium values from the solvent with a 1.0*N* acidified salt solution. Some emulsion problems were encountered; however, by proper *p*H and flow control the operation of the solvent circuit was essentially trouble-free. Solvent extraction data obtained while treating the Ohio Oil Co. lignites indicate a minimum solvent loss of 0.34 U.S. gal. of made-up solvent and 0.41 gal. of kerosene per 1,000 gal. of pregnant solution treated. Approximately 0.4 lb. MgO/lb. U_3O_8 was required to precipitate the uranium values from the pregnant chloride solution. The final product averaged 71% U_3O_8.

While using a secondary amine in the solvent circuit it was found necessary to maintain the molybdenum content of the stripped organic returning to the extraction circuit at approximately 0.5 g. Mo/l. in order to prevent precipitation of a molybdenum-amine complex. Therefore, one quarter to all of the stripped organic flow was, of necessity, scrubbed with a 10% Na_2CO_3 solution to remove the molybdenum.

An optimum overall uranium recovery of 89% was obtained by (1) dead roasting the lignite to 2.5 to 5% loss on ignition, controlling roaster temperature at 1,300°F. in the bed and 1,550°F. in the freeboard, and adding enough air to obtain at least 3.5% O_2 in the off gas; (2) leaching the ashed product in a two-stage leach circuit at 80°C. with sulphuric acid with a thickener between stages; (3) washing in two thickeners and a filter with 4 tons of water per ton of ash; and (4) solvent extraction of the acid wash liquors with an unsaturated secondary amine.

A. HEGARTY

REFERENCES

[1] R. A. Ewing, *et al.*, ' Recovery of Uranium from North Dakota Lignites', B.M.I.-237, June 1, 1955.

[2] K. B. Brown, *et al.*, ' Recovery of Uranium from Lignites', progress report, O.R.N.L. 1569, June 1, 1955.

[3] R. J. Woody, *et al.*, ' Laboratory Investigation of Dakota Lignites', WIN.-54, April, 1957.

The AMERICAN Scene

A summary of recent happenings in the United States

Cheap production of alumina and other products from coal-mining wastes is the prospect held out by the Udy process, developed by Strategic Materials Corporation, in which the North American Coal Corporation are now interested. We learn from Mr. R. L. Savage, vice-president of research for North American Coal, that there are actually three types of reserves available as raw material for the proposed alumina recovery process. The company's major interest is in utilising the current production of rejects from the coal-cleaning plant at Cleveland, Ohio. At present, it is necessary to transport this material to the dump piles and the cost of such an operation increases from year to year as the distance to the dump piles becomes greater. Daily production of this mine waste from each of the two mines at this location is about 1,500 tons/day. Naturally, the company controls its mining operations to make a minimum of such material. However, the quantity could be increased with very little effort or increase in mining costs.

In addition to the current production of waste material there are 10 million tons of material already above ground in the waste piles. This is normally divided into two grades. In years past the proper procedure for spreading the waste material was not understood and the result was that the carbon material still in the waste underwent spontaneous combustion so that some of the piles are burned out. This material is referred to as ' red dog ' and generally has the highest alumina content. Within the past 10 to 15 years the piles have been laid down so as to avoid spontaneous combustion, but the carbonaceous material does oxidise over a period of time. This material is referred to as ' gob.' The alumina content in the gob piles is intermediate between the cleaning plant reject and the red dog. In addition to these materials there is a tremendous tonnage, equal to or greater than the coal reserves in the area, of a soapstone-like material which is high in alumina. This is not even brought to the surface in current mining practice except to clean out certain passageways for air circulation, but it would be available at a very low cost.

A typical range of analyses of the various materials would be as follows:

	%
Al_2O_3	16—25
Fe_2O_3	3—15
SiO_2	40—60
Sulphur	5—12
Carbon	5—15

In general, the process consists of reacting the mine waste material with concentrated sulphuric acid to convert the aluminium and iron values to the soluble sulphates. These can be leached and separated from the silica residue by filtration. Separation of the soluble sulphates followed by decomposition of the iron and aluminium sulphates results in the production of iron oxide and alumina. Sulphur dioxide and trioxide gases from the decomposition are recovered as sulphuric acid for recycle in the process. The advantage in Udy's process over the numerous acid processes which have been proposed in the past lies in its ability to successfully separate the sulphates at low cost. The economics of the process require low cost and efficient recovery of the recycle acid and Udy has made some improvements at this point also.

There are numerous interesting possible variations to the process, including such things as getting the make-up acid requirements from the high sulphur content of the waste material, all of which could be done in an integrated process. Obviously, the process could be used on other high-iron and high-silica materials such as high-iron bauxite, red mud waste, fly ash and certain clays. Some of these are being investigated. The advantage in using the mine waste materials lies principally in their location with respect to the aluminium reduction plants which are moving into the Ohio Valley area and the very low cost of these materials to the process.

$

Experiments in making titanium metal by reducing titanic chloride with sodium have been making good progress. Metallurgical studies have been carried out at the Bureau of Mines laboratories at Boulder City, Nevada, which were responsible for developing the magnesium-reduction method now used by American industry to produce titanium metal. The new experiments with sodium were conducted as part of a continuing programme to improve techniques for extracting titanium from its ores.

The experiments have included the reduction of titanic chloride with sodium at both low (97.5 to 200°C.) and high temperatures (1,000°C.). Reduction in two stages was accomplished with a special reactor.

Details of the experiments have been released in a technical report issued by the Department of the Interior (Report of Investigations 5398, ' Sodium Reduction of Titanic Chloride ').

$

The U.S. Air Force has awarded a contract for the study of high-temperature inorganic polymers and the chemistry of new solid rocket propellant components to the United States Borax Research Corporation. The contract, which will be carried out in co-operation with the materials laboratory of the Wright Air Development Centre, is in support of research on inorganic polymers and plastics,

resulting from the requirement for new materials that will withstand temperatures of 1,000°F. in missile and aircraft applications.

Present-day polymers based on organic-carbon compounds are unstable at these high temperatures, but it is predicted from theory that inorganic materials, containing little or no carbon, will be thermally stable. The exact nature of the inorganic polymer components to be investigated in connection with this contract has not been disclosed, but it is expected that boron, nitrogen and aluminium will occupy an important place in the development programme.

$

As a result of their collaboration with Société de l'Azote, Belgium, on the new method of producing acetylene from natural gas, naphtha and other liquid feedstocks (see CHEMICAL & PROCESS ENGINEERING, April, p. 131), M. W. Kellogg Co. are offering two types of burner, depending on the feedstock used. Type 1 is for natural gas and uses a simplified mixing principle which, according to information put out by Kellogg, requires a much smaller and less complicated mix chamber than other processes. This simplified mixing principle permits operation at elevated preheat temperatures for maximum yields. Carbon is continuously removed from the burner by the use of a water screen. The design of the reaction chamber minimises carbon formation from overcracking.

Type 2 burner is for producing acetylene from propane, butane, natural gasoline, naphthas and other liquid feedstocks, which approaches a true cracking operation. Here, fuel is burned in a combustion chamber. The feedstock is injected as a vapour into the hot combustion gases beyond the combustion zone. The fuel used for combustion can be the cracking stock itself, the gas formed by pyrolysis in the burner, or other hydrocarbon gases. In addition to acetylene, ethylene is produced in various controlled amounts depending on operating conditions.

Figures on production costs that have been made available show that, for a plant with an investment cost of $4 million and using natural gas as feedstock to produce some 20 million lb. p.a. of 99.6% pure acetylene, the net cost of acetylene production, including feedstock, oxygen, direct operating cost, tax and insurance, interest on investment, and making allowance for a return of $240,000 on tail gas, is $1,439,200 p.a., or 7.19 cents/lb. For a plant using naphtha to produce the same quantity of acetylene of 99.5% purity, and costing $4.7 million in investment, the net cost is $1,921,000 p.a., or 9.6 cents/lb.

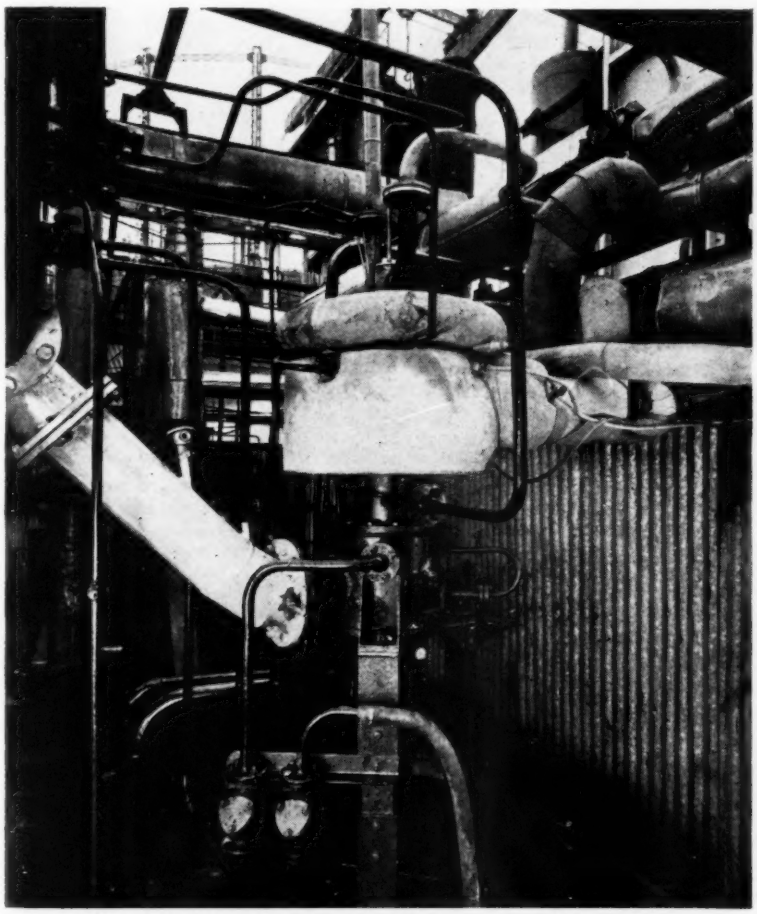
Tail gas from the recovery unit is an attractive feedstock for further processing to methanol, ammonia, etc. Process units can be engineered to recover ethylene produced from the liquid feedstocks.

$

Work on the production of useful power from thermonuclear fusion is advancing on a very broad front in America, with four main systems being investigated. Experimental work in the Sherwood project is concerned with the plasma, the very dilute, extremely hot gas confined by strong magnetic fields. As in the British programme, there are three successive aims or stages in producing thermonuclear power. Firstly, means must be found to raise the plasma to the so-called ignition temperature, when the power emitted from the plasma is equal to the power put in. Following this, work will begin on the design of a thermonuclear reactor which will produce power in significant quantities.

There seems to be a general belief in American laboratories that the ignition temperature will be reached within a few years. However, a fusion machine working at this energy level might not be a net power producer, because all heat losses have to be made up and, in addition, power is consumed by all the equipment necessary to make the reactor operate. The analogous situation in the fission reactor is when a critical reactor does not necessarily produce enough to drive the pumps, fans and auxiliary equipment keeping the reactor in operation.

So far, there is no real proof that a thermonuclear reactor producing net power can be built. It is not certain



S.B.A. Type 2 burner producing acetylene from liquid feedstocks (M. W. Kellogg Co.).

yet that the plasma will be stable at the relatively high density and temperature which are required. For this reason, machines of relatively large power are treated as research tools. At present, the main job is to reach the ignition temperature. Experience leads to the belief that several successive generations of machines, of increasing complexity and power, will have to be built.

The present situation is reviewed in a statement by Dr. A. E. Ruark, chief of controlled thermonuclear research in the U.S. Atomic Energy Commission's research division. He points out that there are four main approaches to the problem of igniting the plasma: the pinch method, in which powerful currents are passed through the gas; the 'mirror' technique, in which energetic ions (with accompanying electrons) are injected into a strong field provided by two large coils; the method employed in the Princeton *Stellarators*, where a small current is passed through a cold gas, confined by a very strong magnetic field, and then a larger current is caused to flow by transformer action; and, finally, the work being carried out on filling a confinement space with super-hot ions.

The question of stability of very hot plasmas may eventually single out one or more methods in preference to others. There are various modifications, hybrid methods and basic ideas which may be called into play. There is general optimism in all four American laboratories about further advances for the period just ahead.

£ s d

CHEMICAL PLANT COSTS

Cost indices for the month of July 1958 are as follows:

Plant Construction Index:	173.5
Equipment Cost Index:	164.1

(June 1949 = 100)

£ s d

INDUSTRY REPORTS . . .

Heavy chemicals in Germany

A considerable rise in the production of inorganic chemicals is recorded in the annual report of Farbwerke Hoechst A.G. Work on considerably extending installations for the production of chloride and caustic soda began during the year. The associated company, Knapsack-Griesheim A.G., began work on a second 40,000-kw. carbide furnace and it was expected to be commissioned in the autumn of 1958. The use of calcium cyanamide in agriculture continued to grow, while output of phosphorus and phosphates rose considerably.

The total turnover of Farbwerke Hoechst and its associated companies rose by 18.9% and the export ratio rose to 32% compared with 30% in the previous year. Of the total turnover, 74% went to countries which now form part of the European Common Market.

The turnover of the chemical industry in the Federal Republic rose by 11.4% during 1957, and thus considerably exceeded the rate of increase of German industry as a whole, which amounted to 7.5% only. However, expansion in the chemical industry is likely to slow down as it has done in industry as a whole.

New rubber processes

The use of smoked sheet in place of latex for the preparation of a modified rubber may well assist in reducing costs and, although such substitution in the production of *Heveaplus* has so far shown no advantage, results obtained with anti-crystallising rubber from smoked sheet on pilot-plant scale have been sufficiently promising to justify continued trials. Success with this particular material should show considerable economic advantage, states the annual report of Rubber Technical Developments Ltd.

In the case of liquid rubber compounds, the attractiveness of a new processing technique has been proved, but improved physical properties of the vulcanisate are required. A new approach has therefore been made by polymer reinforcement of depolymerised rubber. Much has yet to be done, but trials have already shown that in this way it is possible to obtain rubbers with improved physical properties using castable fluid compounds.

Phthalate plasticisers and aromatic chemicals

Major capital expenditure of the order of £790,000, of which £586,000 was at the new site at Widnes, was reported by the chairman of A. Boake, Roberts & Co., Mr. F. G. Pentecost, in his annual review of the company's affairs. At Widnes the company began to commission parts of the new plant for the manufacture of phthalate plasticisers during January, and despite initial teething troubles useful tonnages of saleable products have been produced. Mr. Pentecost anticipated that the plant would be capable of operating at full output during the second half of the present year.

Boake, Roberts have made arrangements with the Glidden Co. of Cleveland, Ohio, for the manufacture under patents of aromatic chemicals by a synthetic process as well as an exchange of research information between the two companies.

It was also reported that, while the company's total sales during the year showed a modest increase, exports increased by about one-sixth and now represent 20% of turnover.

Oil refining

Some 184,800 tons of crude oil was processed at the Ellesmere Port refinery of Lobitos Oilfields Ltd. during the year reviewed by Mr. F. C. Bowring, chairman of the company. The platformer unit went into operation in March 1957 and has operated efficiently, while the sulphonation plant, construction of which was completed at the end of 1957, is now also in operation.

There was discouraging news from Peru, where there were adverse trading conditions for refined products, and from Ecuador, where, owing to the unremunerative refined products prices prevailing, it was decided by Anglo-Ecuadorian Oilfields to suspend construction of their new refinery and to reduce field operations. The chairman of Lobitos expressed the hope that the Governments concerned would realise how essential it is to the interests of the economy and well-being of their countries that the oil industry should be placed in a position to operate profitably and so develop their natural resources fully.

Plastic laminates

Keen competition and low prices for *Formica* products in the export field were referred to by the chairman of Thomas de la Rue & Co., Mr. B. C. Westall, at the annual general meeting. During the year Formica Ltd. was formed to acquire all the assets of the plastics division, with the exception of certain interests abroad. A holding company is to be formed to control all the companies manufacturing *Formica* products in the U.K., France and Australia, and will probably have the name of Formica International Ltd.

Company News

More than 60 visitors from France and leading industrial concerns in Britain were recently welcomed at the Harlow, Essex, factory of Sunvic Controls Ltd. to see the first completed units for the data handling system being supplied by Sunvic for the U.K.A.E.A. uranium diffusion plant at Capenhurst. This, it is claimed, will be the largest data handling system in Europe, consisting of eight units and two mobile printers plus control room equipment. It will continuously and automatically scan more than 2,000 points at which are measured the temperatures of the uranium hexafluoride, glands, pump motor bearings, cooling water temperatures as well as motor currents and voltages.

*

A new company—Chemical Equipment Engineering Co.—has been established at Macclesfield, Cheshire, by Mr. S. Hopton. The firm will be concerned with the design and erection of process plants, solvent recovery plants, agitation and mixing equipment and rotary vacuum filtration equipment. Design and construction of froth flotation plant for the cleaning of fine coal will be another important activity.

Mr. S. Hopton has relinquished his position as director and general manager of Stockdale Engineering Ltd. in order to devote all his time to the new enterprise. He plans to develop plant and equipment of particular interest to chemical manufacturers, and further details of these developments will be announced in the near future.

*

To meet increasing demand for protective plastic linings in industrial plant the *Ensecote* department of Newton Chambers & Co. Ltd. at Thorncliffe, near Sheffield, has been modernised, extended and largely rehoused. At the same time, by means of a continuing programme of research and development, advances are being made in the quality of the linings applied to various kinds of equipment and tanks. Generally speaking, these linings are designed for use at fairly high temperatures and to give protection against corrosive conditions.

There is a finishing shop which is able to handle materials or fabrications up to 65 tons in weight and to about 120 ft. in length. Of special interest is the new pressurised spraying chamber in which the air is filtered in order to prevent dust affecting coated surfaces during the various stages of treatment. In this spraying chamber also is the newest type of water-washed wall which not only ensures that air conditions inside the shop are good but cleans and filters the air expelled into the outside atmosphere, so eliminating any nuisance which might be caused to adjoining departments. There are, too, facilities for heating the air entering the spraying room when this is necessary in winter or at other times.

Other new plant includes two shot-blasting cabinets with facilities for their use end-to-end so that when the dividing partitions are opened vessels up to 10 ft. in diam. and 40 ft. long can be accommodated. Provision is made for shot-blasting with equal efficiency both inside and outside vessels.

Newton Chambers' *Ensecote* linings were a subsequent development to the *Lithcote* linings acquired from an American company and enable the department to handle plant for a much wider range of chemicals than was at first considered possible.

Honeywell Controls Ltd. recently celebrated the official opening of its new head office building in Greenford, Middlesex. The building was declared open by Mr. Harold Sweatt, chairman of the Honeywell organisation, who had come over from Minneapolis, home of the company's American associates, for the ceremony. He drew attention to the fact that, although Honeywell Controls had started making instruments only eight years ago, they were already among the largest manufacturing companies in the U.K.

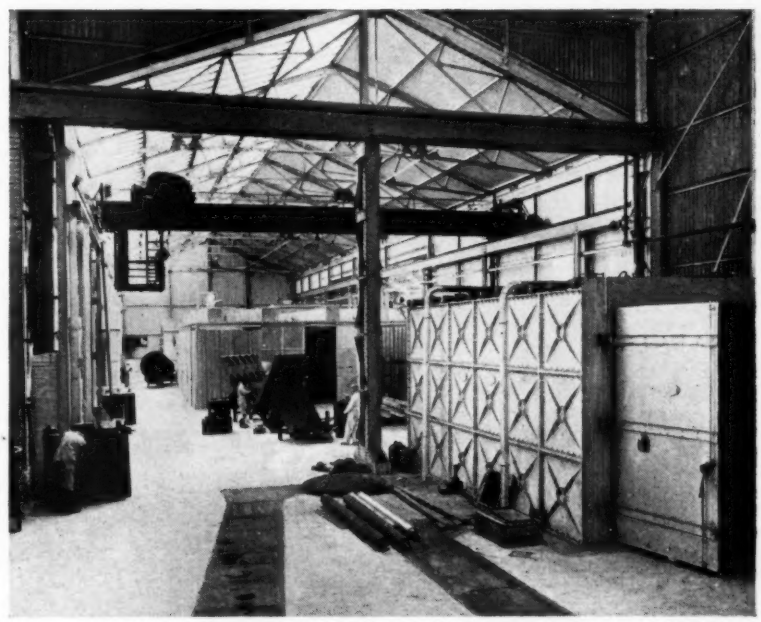
*

The United Kingdom Glycerine Producers' Association Ltd. announce that the name of the grade previously sold by its members as pale-straw glycerine will in future be technical-grade glycerine, and that the specific gravity of both chemically pure and technical-grade glycerine has been increased from 1.260 to 1.2627.

The new gravity will correspond to a glycerol strength of 99% and no change in price will result from the change.

Change of address

Opperman Gears Ltd. announce the transfer of their northern area office from Leeds to 20 St. Ann's Square, Manchester. This office will be under the supervision of northern area manager Mr. M. G. Marsh.



A general view of the main finishing shop in the modernised 'Ensecote' department of Newton Chambers & Co. Ltd. at Thorncliffe, near Sheffield. In the foreground is the shot-blasting chamber, the air-conditioned spraying chamber in the middle distance, and a battery of stoving ovens at the end.

Personal Paragraphs

Left to right:
T. S. Ling,
A. C. Bureau,
G. P. Balfour.

★ **Mr. G. P. Balfour** has been appointed managing director of Stockdale Engineering Ltd. Mr. Balfour, who joined the company in this capacity recently, had early experience in production and process development in the field of metal powder manufacture, being later concerned with oil refinery design, ranging from individual equipment to complete refineries. During the past ten years he has worked on methods of liquid/solid and liquid/liquid separation, being managing director of Sharples Centrifuges Ltd. from 1952 till his recent appointment.

★ **Dr. J. D. Armit** has been appointed a director of Triplex Holdings Ltd., which controls the Triplex Safety Glass Co. Ltd., and the group's chemical-glassware and engineering subsidiaries, including Quickfit & Quartz Ltd., Q.V.F. Ltd., Weldall & Assembly Ltd., and Stern & Bell Ltd. Formerly a director of I.C.I. and war-time Director-General of Explosives at the Ministry of Supply, Dr. Armit has for some years been consultant chemist to the Triplex group, working in association with **Dr. A. C. Waine,** research director of the Triplex Safety Glass Co.

★ **Mr. P. S. Beale** has been appointed a director of the British Oxygen Co. Ltd. and **Mr. R. J. Barritt** has been appointed chief executive of the engineering division.

★ **Mr. E. R. Blane** recently figured in a ceremony arranged by Mobil Oil Co. to mark the end of his service with the company as consultant in the technical services laboratory. He was appointed to this position on his retirement in March 1956, after over 20 years' service. During his service with Mobil, Mr. Blane has been responsible for much original work on process products, particularly on emulsions, tanners' products and cutting and rolling oils.

★ Nordac Ltd. recently announced the appointment of **Mr. A. C. Allison** as their technical representative in Scotland. He is the first resident representative the firm have had in Scotland for some time.

★ **Dr. N. Levin,** who since 1955 has been chief of research and development of Rank Precision Industries Ltd., becomes a Deputy Director of the Atomic Weapons Research Establishment at Aldermaston. He will continue to be associated with Rank Precision Industries and Rank-XeroX Ltd. in a consultatative capacity on research and development.

★ Two of the Balfour Group staff have been appointed to the board of directors of Ernest Scott & Co. Ltd. and George Scott & Son (London) Ltd. They are **Mr. T. S. Ling** and **Mr. A. C. Bureau,** the latter being also director and general manager of Balfour Lecocq Ltd., and gas consultant to Henry Balfour & Co. Ltd., while Mr. Ling is in charge of the Rietz Division of George Scott & Son (London) Ltd.

★ **Mr. R. T. Hayes** has been appointed a director of United Coke & Chemicals Co. Ltd., a subsidiary of the United Steel Cos. Ltd. Mr. Hayes, who joined the group in 1946, is commercial manager of United Coke & Chemicals, and of United Steel's Ore Mining Branch and the Santon Mining Co. Ltd.

★ Fisher Governor Co. Ltd. announce that **Mr. W. J. Pearson** has been appointed sales manager for the continental range of butterfly valves which the company are now manufacturing in England.

★ **Mr. Tito Giusti,** who died recently at the age of 86, will be remembered as one who pioneered the use of stainless steel in ice-cream freezers, and later extended his interests into the dairy and chemical plant fields. A naval architect by profession, he first came to Britain in 1908, having been invited by the Admiralty to help design surface craft for the Royal Navy to combat the threatening German U-boat menace. He had already built himself a reputation as a naval architect in Italy, but probably one of his lesser known commissions was to design a small pleasure boat for his great friend the composer Giacomo Puccini. He was also a friend from his student days of Marconi, the wireless pioneer. He founded the firm of T. Giusti & Son Ltd. in 1918.

New welding technique reduces 'piping' in pipe joints

'Piping' (also known as 'worm-holes') is a common fault in pipe butt welding, especially by the upwards method. The simplest and most direct definition of piping is that given in British Standard 499 : 1952 ('Glossary of terms relating to weld imperfections'); here a pipe or worm-hole is defined as 'an elongated or tubular cavity due to entrapped gas.'

Piping frequently occurs in the root run of a pipe joint, particularly when a heavy weld is deposited and when the penetration bead is rather large. Thus it is most likely to occur in areas of excess penetration, *i.e.* between the nine and twelve o'clock positions in a pipe joint. Recent research in the laboratories of Quasi-Arc Ltd. and reports from some of the firm's customers have shown that piping can be considerably reduced by the use of a wider root gap. This may seem rather contradictory, since a wider gap would seem to indicate a larger root run, but, in fact, if the gap is sufficiently wide it is possible to reduce the amount of heat right in the centre of the pool where piping usually occurs. This is achieved by using a weaving technique with a slight pause at the edges and a rapid flick across the centre of the pool which keeps the weld bead as thin as possible.

The work carried out has shown that the gap should certainly not be less than $\frac{1}{8}$ in. and should preferably be of the order of $\frac{3}{16}$ in. with a $\frac{1}{16}$-in. root face. This applies to all thicknesses and diameters of pipe, but does not apply where the pipe is welded by the 'stove-pipe' or vertical downwards method. It is, of course, advisable to use as small an electrode as possible, preferably 12 s.w.g., but certainly not more than 10 s.w.g., for all root runs in pipes welded by the upwards method.

World News

SOUTH AFRICA

Recovery of titanium ore

A £1½-million plant for the recovery of ilmenite and rutile, as well as zircon, from a 5-mile stretch of the coast at Umgababa was reported to be nearing completion recently. The project is being undertaken by Umgababa Minerals Ltd., an associate company of the Anglo-American Corporation of South Africa Ltd. The plant and machinery were fabricated partly in the Union and partly in the United States.

It is estimated that production of ilmenite at the plant will be at the rate of 100,000, of zircon 10,000 and of rutile 7,000 long tons.

RHODESIA AND NYASALAND

New fertiliser factory

The new £3½-million superphosphate factory being built by African Explosives & Chemical Industries (Rhodesia) Ltd. is nearing completion. The factory is in four departments: a fertiliser section, a sulphuric acid plant, a phosphoric acid plant and a triple superphosphate section. Most of the raw materials—iron pyrites, arsenic, bauxite and phosphate rock—will eventually come from within the Federation.

FRENCH WEST AFRICA

Mineral extraction

Mining possibilities in the French Soudan are being examined. Manganese, tin, tungsten, copper, iron and phosphates are the subject of prospecting work, while bauxite deposits are being examined for workability. Among the deposits discovered in Dahomey are titanium, copper, iron and rutile.

Part of the nitrogen plant of Kedyierzym chemical works, one of Poland's largest and most modern chemical plants.

BULGARIA

Barite treatment

A large flotation plant was recently built in Bulgaria for improving the quality of barite. The export of dressed barite is to begin this year. Pure white in colour, it will contain as much as 95 to 98% of barium sulphate, and at the most 3% of silica. The fineness of grinding has also been improved, reducing the residue to 30% at the most on a 6,400 mesh/sq.cm. screen.

The whole production of the new factory is to go for export.

INDIA

French advice on aluminium project

Mr. R. Venkataraman, Minister for Industries and Labour, Madras, recently visited aluminium factories in France and Italy, where he had discussions with industrialists on the possibilities of setting up an aluminium plant at Salem. The French experts, he said, had made a preliminary report on the prospect of a project in Salem, and had mentioned that they would take further steps in the matter if called upon to do so. Nobody, apparently, has ascertained the quantity of bauxite available in the Salem area.

ISRAEL

Sulphuric acid from gypsum

A plan for the construction of a plant to produce sulphuric acid and cement from gypsum, which is available in large quantities at Makhtest Ramon in the Negev, was recently being studied by the Ministry of Commerce and Industry.

JAPAN

Chemical helps in rice production

The Technical Research Institute of the Ministry of Agriculture was reported to have invented a chemical compound which, when applied to paddy fields, prevents evaporation of moisture and the consequent lowering of ground temperature. The compound, called OED, was said to be composed of high-grade alcohol with an alkyl base and ethylene oxide. Comparative tests indicated that a paddy field treated with this compound was subject to up to 95% less evaporation than an untreated one, and kept a temperature several degrees higher.

Polythene

The Mitsui Petrochemical Co. and the Sumitomo Chemical Co. were reported to be ready to put domestically produced polythene on the market for the first time. Mitsui was said to have a production capacity in its Iwakuni factory of 12,000 tons each annually of polythene, toluol and xylol, 6,000 tons of ethylene oxide and 4,800 tons of ethylene glycol. Only

Contracts

Courtaulds Ltd. announce that negotiations have been successfully concluded with Technopromimport, Moscow, for a contract to supply machinery for a factory which is being constructed in Russia. The factory will manufacture cellulose acetate yarn from Russian-made raw materials.

Some of the machinery will be fabricated in Courtaulds' workshops at Coventry; some will be supplied by other U.K. firms to Courtaulds' requirements and specifications. Courtaulds have undertaken the responsibility for supervising the erection of the machinery and for putting the acetate yarn factory into production.

The value of the contract amounts to some millions of pounds.

★

W. C. Holmes & Co. Ltd. have received an order from Babcock & Wilcox Ltd. for two electrical precipitators to be installed after the two 200-mw. reheat boilers, with pulverised fuel firing, at the West Thurrock power station of the C.E.G.B.

★

An ethylene oxide/glycol plant is to be designed by Scientific Design Co. Inc., U.S.A., for Mitsubishi Petroleum Co. Ltd., Yokkaichi, Japan. The plant will approximately double Japan's ethylene oxide production and will be the second to be erected in Japan using the S.D. direct-air oxidation process. S.D. will supply the process under licence, over-see construction and initial operation of the plant, and supply the special catalyst required.

Ethylene oxide, ethylene glycol and other petrochemicals will be produced by Mitsubishi from raw materials supplied by Showa Oil Co.

the last two items would be put into full production at once, the others being produced at half-capacity rate for the present. The Sumitomo factory at Niihama was said to have an annual capacity of 11,000 tons of polythene.

NORWAY

Exploitation of lignine

The wood processing concern A/S Borregaard has a new plant for exploiting the lignine which is a residue in the waste sulphite liquor together with the sugar. The lignine will now be applied as fuel by a new wet oxidisation process, saving the company at least 50,000 tons of imported fuel yearly. This Zimmerman process was developed on laboratory and pilot-plant scale in the U.S.A., but A/S Borregaard, it is claimed, is the first to develop it on a full technical scale, and holds the complete exploitation rights for the pulp and paper industry in Europe.

Aluminium production increased

A/S Norsk Aluminium Co. has carried out considerable expansion work at its factory at Höyanger, West Norway. Forty-four new electro-furnaces have been installed, and when regular operation is commenced—probably by September—the factory's aluminium production will be increased from 9,000 to 13,500 tons p.a. The production increase will be taken over by the subsidiary company's factories at Holmestrand—A/S Nordisk Aluminiumsindustri—which at present have to purchase 4,000 to 5,000 tons of metal annually from abroad.

Oil refinery started

The Norwegian Esso Co. recently started the construction of its new 40,000-bbl./day oil refinery near Tönsberg on the Oslo fjord. Such industry is, however, not new to the Tönsberg vicinity, as Europe's oldest refinery, Vallöy Oljeraffineri, has been in operation there for 30 years. This is also owned by Esso, and has a capacity of 12,000 tons of mineral oil products p.a.

New carbide factory

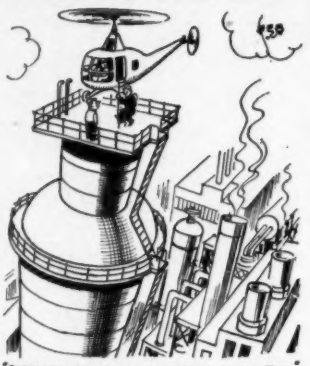
The Norsk Hydro electro-chemical concern recently opened a new carbide factory at Hercya, to produce 30,000 tons p.a.

PORTUGAL

Chemical and metallurgical plans

The Atomic Energy Board intends to set up an installation to produce metallic uranium from uranium salts

Comical Engineering Corner



obtained from Portuguese mines. The uranium produced would be used in reactors which may be set up, or could be exported.

The Sociedade Portuguese de Petroquimica and Nitratos de Portugal have been set up to produce from refinery sub-products 120 tons/day of ammonia, 250,000 cu. m. of town gas, and 80,000 tons p.a. of nitrogenous fertilisers from ammonia, together with 12,000 tons p.a. of ammonia to be supplied to the ammonium sulphate industry. The production of 70 tons p.a. of fertiliser containing nitrogen and phosphorus has also been authorised.

The Leonard Hill Technical Group—September

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist—Work Study and Pipeline Design; The Synthesis and Applications of Acyl Halides; Wetting Agents for Agricultural Sprays; Silicone Polishes.

Corrosion Technology—Anodising Bath for Magnesium Alloys; High-pressure Phenolic Laminates in Chemical Plant; Protecting Steelwork with Epoxide Enamel.

Petroleum—Belayim Crude, Advantages of Coking, 2; New Metals in the Oil Industry; Operational Control Equipment.

Paint Manufacture—Conference on High Polymers; Aluminium, Versatile Pigment; Fading of Printing Inks, 2; Epoxide Resins.

Atomics & Nuclear Energy—The Significance of Geneva; How Radiation Damages Metals; Isotopes Measure Engine Wear; Selection of Reactor Coolants.

World Crops—Potash Manuring; A Complete Fertiliser; Organic Irrigation.

Food Manufacture—Autoxidised and Heated Fats as a Nutritional Hazard; Ultrasonics in Food Manufacture; Progress in the Glass Container Industry.

The steelworks coke ovens will permit the production of 60,000 tons p.a. of ammonia which, together with the enlargement of the installations already proposed to produce nitrogenous fertilisers, will mean the production, from 1961 onwards, of from 75 to 100 thousand tons more of ammonia.

With the establishment of new enterprises, it is hoped to increase the production of wood pulp for paper from 25,000 to 115,000 tons p.a., with an increase in the consumption of eucalyptus wood of 300,000 tons p.a.

CHINA

Chemical and allied projects

Chemicals. The chemical plant at Peking is being enlarged, and it is hoped that by the end of this year it will be in a position to produce reagents, rubber anti-oxidant, catalysts, titanium, strontium, zirconium, tantalum, beryllium and molybdenum. It is said that this plant will provide raw materials for the atomic energy industry. The Yungli-Chiuta chemical works in Tientsin are also being expanded to provide for an annual output of 160,000 tons of ammonium chloride and pure soda. A new gas-compressor has been installed in Nanking to provide a 20% increase in the production of liquid ammonia.

Fertilisers. Construction has begun of a new chemical fertiliser plant in Kaifeng, Honan. By next year it is to produce 200,000 tons of phosphate fertiliser and a similar quantity of nitrogenous fertiliser. Double superphosphate will be produced at a later stage. A fluorineless phosphate fertiliser has been produced from quartz, phosphorus and coal dust by the Shanghai Chemical Engineering Research Institute. A small 8,000-ton nitrogenous fertiliser plant has begun production in Shanghai. It is said to be the prototype of 36 such plants to be built this year in various parts of China.

Fibres. Seven chemical fibre plants are to be begun in Shanghai this year. They are scheduled for completion by 1962 and are expected to produce 60,000 tons of synthetic and viscose fibres annually. The products will include *Terylene*, artificial silk wool and cotton, kapron, acetate fibre and nylon 66. China's first rayon factory began production in Shanghai at the end of April. Estimated annual output is 500 tons of yarn. Caprolactam has been experimentally produced by the Chinhsi chemical works in Liaoning Province. Construction of the Angung chemical fibre plant has been completed.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Finishing stainless steel for chemical process plant

Rapid progress in the development of new fabrication techniques, particularly for stainless-steel products designed for chemical processes, has been apparent over the past few years. In high-grade grinding and polishing, high spindle speeds are required and much production polishing is done on lathes. For more intricate work, as for example the blades of paddle mixers and the corners of vats, etc., high-frequency electric tools are available, such as the *Hicycle* tools offered by Consolidated Pneumatic Tool Co. Ltd. The solid or copper bar motors used with these tools are claimed to be practically indestructible and capable of maintaining constant speeds of up to 16,000 surface ft./min.

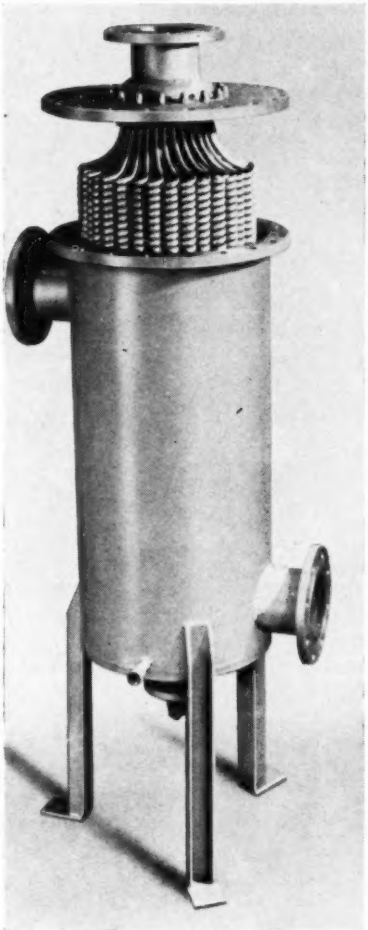
For its *Hicycle* grinder, the company has recently introduced a special extension to deal with close-quarter polishing, where high-grade workmanship must be maintained in a confined space. **CPE 981**

Centrifugal fans for corrosives

Low- and medium-pressure centrifugal fans for the extraction of corrosive fumes, made by Permali Ltd. and marketed by the British Fan & Electric Co. Ltd., are made from polyester resin and chopped strand mat which, the makers point out, is suitable for most applications. The cases are produced from matched metal moulds which give uniformity of thickness and dimensional accuracy. The impellers are made from a dough material. Epoxy resins can be used in place of polyester where necessary.

These fans are used in place of cast-iron fans because of their resistance to acids and alkalis, except halogen gases, when exhausting chemical fumes. They are approximately 50% more expensive than cast iron, but have the added advantage of considerably reducing the noise factor by eliminating the hum during operation. This is because the impeller does not have a 'tip' vibration.

The *Permaglass* range of high-strength reinforced plastic materials made by Permali Ltd. are used not only in extraction fans but also in ducting, plating and pickling bath covers and drying trays as well as in marine, aeronautical, electrical and various other fields. Advantages include high strength-to-weight ratio, dimensional stability and good temperature resistance as well as resistance to chemicals and immunity against all forms of micro-biological attack. **CPE 982**



'Helitube' heat exchanger.

Helical-tube heat exchanger

A new heat exchanger, the *Helitube*, represents a breakaway from the conventional hairpin and floating-head types of heat exchanger, the heat-exchanger surfaces consisting of narrow tubes tightly coiled into a helical shape and housed in an external jacket. The tubes, which can be either copper, steel, aluminium or stainless steel, are seamless and are secured in the tube plates by means of a tight-fitting ferrule which beds the tube into grooves in order to effect a perfect seal. If steel tubes are used they are welded into the tube plates. It is claimed that both methods of fixing the tube ends ensure a perfectly tight seal and that throughout their life there can be no movement of the tube ends.

The tube plates are rigidly fixed in the tube jacket without the necessity for expansion plates or floating heads. Any vibration or expansion or contraction caused by high variations in temperature are taken up in the light springy action of the tubes, and no stress is put on them.

High overall heat transfer is achieved

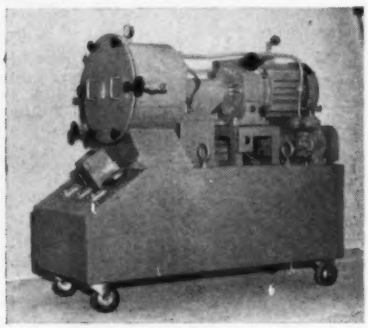
C.P.E.'S MONTHLY REPORT AND READER SERVICE

since the tubes are of a small bore, normally not more than ½ in. diam., which ensures intimate contact with the heat-transfer surfaces of all the liquid, and at the same time turbulence is maintained. The flow of liquid in the jacket runs almost at right-angles to the helical coils and inwards and outwards over the surface of the tubes, ensuring the greatest percentage of surface coverage.

Further details are obtainable from British Boiler Accessories Ltd., or from the C.P.E. Enquiry Bureau, quoting: **CPE 983**

Continuous deaerator

An addition to the *Centri-Vac* range of continuous deaerators for fluids and pastes carries a 15-in. spreader disc against the original model's 26-in. disc, and has been designed specifically for use either on reasonably small production rates, or for laboratory research work on various types of products. It has an infinitely variable



Laboratory continuous deaerator.

speed drive, capable of running as low as 450 and as high as 4,300 r.p.m.

In this equipment it is possible to deaerate fluids and pastes under vacuum, or conversely to gasify fluids and pastes by pressurising the operating chamber.

Bowser, Monks & Whitehouse Ltd. are the makers. **CPE 984**

Heater unit

The *Simoon* heater unit has been developed by Martindale Electric Co. Ltd. for use in conjunction with their portable blowers. It is suitable for a variety of quick-drying purposes, and is available in three sizes, 3, 2 and 1 kw. Its two voltage ranges are 100/130 and 200/250 a.c. and d.c., the average heat generated being from 80 to 226°C. above that of the surrounding atmosphere. A thermal cut-out is fitted to avoid overheating and burning out. **CPE 985**

Cleaning internal surfaces of tubes

Equipment for cleaning the internal surfaces of tubes and piping has been developed by Vacu-Blast Ltd. It is claimed that with the new technique (briefly mentioned in CHEMICAL & PROCESS ENGINEERING for June, page 209), a small range of simple attachments makes it possible to clean practically any shape or size of tube from ⅛-in. bore upwards.

The essential part of the equipment is the Vacu-Blast machine itself. Incorporating a pressure/vacuum system for abrasive feed and recovery with a thorough segregation of grit, slag and dust, the system lends itself to adaptation for tube cleaning which has been a recurring problem since the inception of industrial processes. In effect the tube is used to replace the Vacu-Blast gun with the pressure and vacuum hoses connected at opposite ends, the closed circuit being maintained within the tube body. According to the varying sizes of tube, different methods are employed.

Although the new technique has only recently been introduced, it has been well tried and since its initial development machines have been supplied to a variety of industries. Specific applications range from the cleaning of high-alloy heat-treated tubing for nuclear power plant work, the cleaning of *Nimonic* alloy tubes, steam and oil pipes for thermal power plant installations and process piping for chemical plant. Thus, by reference to several commercial installations it is claimed that a simple method is now available for cleaning pipes and tubing down to virgin metal, the principal exception being where the pipe might contain a thick oily or glutinous substance which, by its nature, will absorb the impact of the abrasive.

In addition to the simple attachments mentioned above, a more specialised item has been developed for cleaning large-bore, straight tubes. This item, known as the rotary head, comprises two rotating blast nozzles driven by an air motor. The assembly is mounted on a carriage and is drawn through the tube while blasting is in progress. **CPE 987**

NEW SURFACE-ACTIVE AGENTS

Two series of ampholytic surface-active agents, which depend for their properties entirely upon the *p*H of the solution in which they are acting, are being developed by Glovers (Chemicals) Ltd. In alkaline media, *i.e.* at *p*H 9 or above, they may be considered to be acting almost wholly in the anion-active form, whereas in acid media at, say *p*H 5 or below, they are acting almost entirely in the cation-active form. At neutrality, *p*H approximately 7, they exhibit properties largely resembling non-ion-active materials. They can, therefore, by careful variation of *p*H, be made to simulate the properties of anion, cation or non-ion-active surface-active agents at will.

The *Amphionics* and *Ambiterics* differ in that in the case of the *Amphionics* there is a point at which the solubility is at a comparatively low value, whereas the *Ambiterics* remain highly soluble throughout the *p*H range. The *Amphionics*, however, are likely to have better colloidal suspending powers than the *Ambiterics*. Derivatives based on the dodecyl radical are superior to those based on the hexadecyl radical from the point of view of wetting, foaming, solubility, etc., whereas those based on the hexadecyl radical have lower solubility and produce less foam, but are better emulsifying and suspending agents.

CPE 986

Transportable oxygen producers

Fully transportable oxygen plants are available which can easily be operated for short or lengthy periods. The plants can be mounted in a vehicle, on a trailer, or on skids. Self-contained, with their own diesel engines, they can also be supplied to operate from local electric power supplies, and can be operated intermittently or continuously. Makers are British Oxygen Gases Ltd. **CPE 988**

Stoneware fume absorber

Consisting of an absorption tower, ejector, pump and liquor tank, a self-contained plant is available to deal with noxious or offensive gases. The stoneware tower, like the ejector, piping and valves, is treated externally with resin-bonded glass fibre, while another important feature is the swirl-type ejector. The unit, produced by Hathernware Ltd., is available in three sizes and can be modified to meet different needs and site conditions. Increased quantities can be handled by using two ejectors in parallel.

CPE 989

Wall-thickness gauge

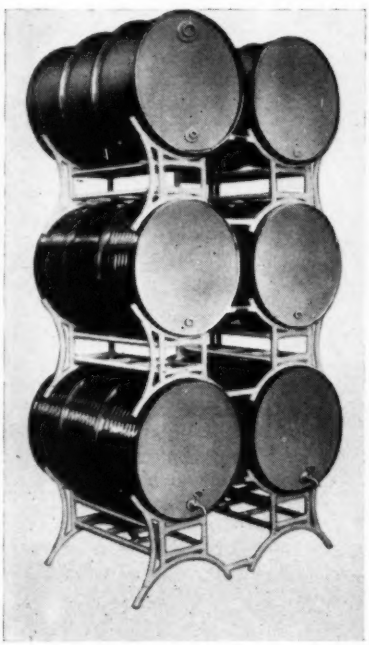
Employing transistors and printed-circuit technique, the type N563 gamma backscatter gauge, by Ekco Electronics Ltd., is a self-contained portable equipment for measuring the thickness of pipe walls or sheet materials to which access is possible on one side only. The measuring head is contained in a convenient pistol-grip unit and provides two ranges of measurement, 0 to 0.25 in. and 0.2 to 0.75 in. **CPE 990**

Machinery stoppage alarm

A device was developed by Londex Ltd., in collaboration with the Imperial Chemical Industries Ltd., using a principle successfully pioneered by the Billingham Division of I.C.I. The original units were for use on stirrers, band conveyors, etc.

This rotation sensing device is for providing an alarm on the stoppage of rotating machinery used for continuous processing. It is easily installed, there being no critical alignment with the monitored drive; functional tests can be carried out by unskilled labour, and this need not interfere with the drive. The casing in which the unit is housed is specifically designed to provide complete protection for all components from corrosive fumes; also very little lubrication is necessary.

The standard unit covers a range of 30 to 300 r.p.m. and both these units can be extended by altering circuit values, and by changing cam characteristics. **CPE 993**



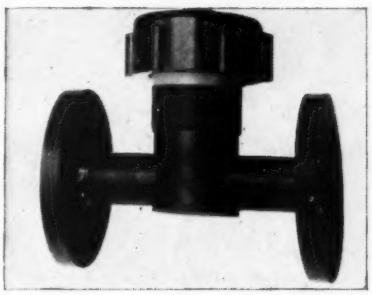
DRUM STORAGE

This storage unit allows steel drums to be stacked up to five tiers high by means of a fork lift truck. Each drum is securely cradled and the forks are always safely positioned under the load during stacking operations.

CPE 991

Corrosion-resisting valves

A new, all-plastic valve is being marketed for use with polythene and rigid PVC pipes and fittings. It is stated to be capable of handling most inorganic liquids or aqueous salt solutions, alkalis and acids. The valve is also of interest to the foodstuff industries, being constructed from non-toxic, tasteless materials.



Polythene and PVC valve.

This valve comprises a moulded polythene body with rigid PVC working parts, glanded with plasticised PVC washers. It is made in two types, line valves and bibcocks, and in four sizes ($\frac{1}{2}$ in., 1 in., $1\frac{1}{2}$ in. and 2 in. bores). The valve is available either flanged or screwed.

The standard models have a moulded body in straight polythene and are suitable for working temperatures up to 65°C. and pressures from 100 p.s.i. for the $\frac{1}{2}$-in. size to 60 p.s.i. for the 2 in. In the near future, the valve will be available constructed entirely from Zeigler-type H.T. polythene, advancing the safe working temperature to 85°C. As an alternative to PVC working parts, it is possible to obtain the valve with H.T. polythene working parts. Makers are Resistant Equipment Ltd. **CPE 992**

Control valve

Compact butterfly valves to handle air, gases, vapours and liquids at low pressure are now included in the range of Fisher Governor Co. Ltd. The body is installed between flanges by through bolts, eliminating strains and breakages and offering little obstruction to the passage of gas or air since the body of the valve is machined so that the internal diameter of the valve is equal to the internal diameter of the nominal pipe size.

These valves can be arranged for diaphragm-motor, lever, hand-wheel and chain-wheel operation, standard and heavy patterns being available. **CPE 994**

Pre-granulating machine

A new addition to the range of W. J. Fraser Ltd. fertiliser and granulating plant is the pin granulator. This consists of a cylindrical trough containing a longitudinal shaft fitted with two rows of pins arranged helically, so that when the shaft is rotating the pins carry the material along. The input fine material and water are kept in agitation by the high-speed rotation, and form small granules which, when fed to a conventional granulator, yield granules of high conformity and low moisture content. In some cases, the machine can be used by itself, without a following granulation stage.

The trough is rubber-lined to reduce adhesion of the particles, and the pins are tipped with extra-hard material to reduce wear. Apart from the manufacture of fertilisers, this machine can be used in many cases where fine materials are to be agglomerated either for making a granular product or in preparation for a further stage of manufacture. **CPE 996**

ISOSEBACIC ACID

Commercial quantities of U.S.I. isosebacic acid are expected to be available for the U.K. by the end of September. This butadiene-derived material is suggested as a low-cost replacement for the pure acid in low-temperature plasticisers, polyamides, polyesters, alkyds and jet lubricants. Samples and technical information may be obtained from Honeywill & Stein Ltd. **CPE 995**

Trihydric alcohol

A solid trihydric alcohol with three primary alcoholic hydroxyl groups has been added to I.C.I.'s range of development products, and a pilot plant is now being operated. Trimethylolpropane is claimed to have a high resistance to thermal degradation, while the three hydroxyl groups react at a more uniform rate in alcoholysis, esterification and other reactions; alone and in its compounds, it is more compatible with organic reagents and solvents than most other triols. It is expected that outlets will be found for it in surface coatings, in the formulation of polyurethane foam and resins, in the polyester resin field, and for ester-type plasticisers.

CPE 997

Non-destructive testing

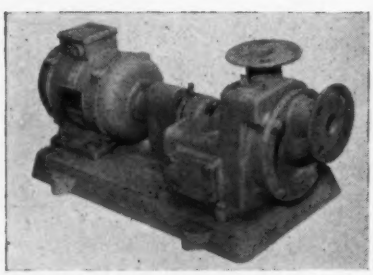
A new radiographic inspection service, for the examination of welds, castings and machine components, has been established by Gammax Ltd., of London. Field inspection engineers are available for on-site operations and laboratory testing facilities are provided. The company manufacture a range of gamma and *x*-ray equipment and accessories. **CPE 998**

Self-priming centrifugal pump

The *Autostart* pump, introduced by Girdlestone Pumps Ltd., works on the recirculation principle, and has an open impeller of special form. There are no valves or fine working clearances. Although it was designed for the chemical industry, its uses include transfer duties from underground tanks, distillate extraction, process work, and the emptying of carboys, etc. Construction can be of various resistant alloys, including stainless steel, a cast-iron pump being available for normal duties.

Mechanical shaft seals are fitted exclusively, types being available for solvents, all water duties, and many acid and chemical solutions.

CPE 999



'Autostart' pump.

★ *American Developments in Brief* ★

A new automatic recording analyser for the ion-exchange chromatography of amino acids and related compounds is announced by Phoenix Precision Instrument Co. The temperature as well as elutrient buffers may be changed automatically at a preset time, so that the machine may be operated overnight unattended. **CPE 1000**

★ ★ ★

A high-speed radiometer has been developed by Radiation Electronics Corporation primarily for remotely measuring the temperature distribution along organic and inorganic fibres during high-speed drawing processes. A complete temperature 'profile' may be obtained in a few seconds. A modification of this has been used for the study of flame and explosion phenomena, and has found applications in industries such as glass, chemicals, primary and fabricated metal production, etc. **CPE 1001**

★ ★ ★

A new type of snap-on urethane insulation has a low k factor, and good resistance to physical damage as well as to chemicals and solvents. Designed for service between −200 to +250°F., the insulation is preformed to fit pipelines and fittings. Allied Chemical International are the suppliers. **CPE 1002**

★ ★ ★

A recording flow photometer that can be used with commercially available metering pumps and accessory equipment for the determination of amino acids and other amino compounds is announced by Phoenix Precision Instrument Co. It is supplied with a recorder which prints three separate absorbance curves in multicolour dots. The instrument is compact, with easily accessible components. **CPE 1003**

★ ★ ★

Primarily intended as a tritium detector, a radioactive-gas survey meter by Levinthal Electronic Products Inc. is useful for detecting leaks in systems containing other radioactive gases as well. Operated from an internal storage battery capable of 12 hr. continuous operation, the instrument has a half-scale deflection sensitivity to 1, 10, 100 or 1,000 microcuries of tritium/litre of air.

★ ★ ★ **CPE 1004**

Molybdenum pentachloride, an active catalytic agent, is being produced in semi-works quantities by Climax Molybdenum Co. It is also a plating compound and a reactive intermediate. **CPE 1005**

★ ★ ★

The availability is announced by Union Carbide International Co., to licensed users outside the U.S.A. and Canada, of uranium concentrate in commercial quantities, as well as reactor grades of both natural and enriched uranium dioxide and uranyl sulphates and nitrates in development quantities. **CPE 1006**

★ ★ ★

Rubber-lined centrifugal pumps of Carl Buck & Associates cover the range from 10 to 1,200 gal./min. at heads of from 15 to 120 ft. No metal is in contact with the acid being pumped, and the lining is an acid-proof semi-hard rubber suitable for all alkalines and acids, except nitric or chromic at temperatures to 210°F., any other synthetic rubber or plastic lining material being also available.

★ ★ ★ **CPE 1007**

A self-powered hydro-scavenger is a recent development of Whittington Pump & Engineering Corporation, and is used for the collection, transport and disposal of liquids, sludges and dust. It is claimed that the machine will handle any material which 28-in. mercury vacuum will pull into it, and which will discharge with 20 p.s.i. pressure. The equipment can also be used for sanitary and chemical fluids, and can be furnished in materials compatible to the material handled. The equipment is supplemented by the self-powered liquid transporter for clean liquids. **CPE 1008**

★ ★ ★

A softer, tougher grade of stainless steel—type 303—is being used for greater corrosion resistance in colloid mills, according to Union Carbide International Co. The bearing surfaces of the rotors are hard-faced and the wearing surfaces are generally highly resistant to both abrasion and corrosion. **CPE 1009**

★ ★ ★

Zirconium is now being used for automatic control valve components, report Columbia-National Corporation. This company claims that zirconium components in highly corrosive liquid chlorine service are more reliable, and outlast stainless-steel parts from 4 to more than 20 times. **CPE 1010**